PB82-201567

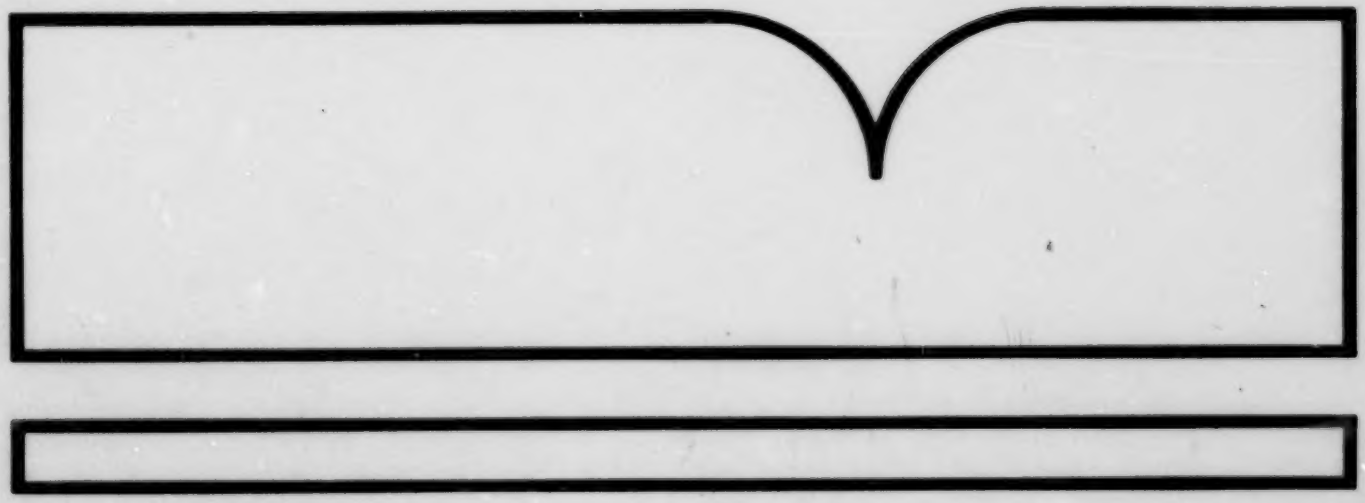
Test Protocol: An Environmental Assessment of Refuse Thermal Processing Facilities

Systech Corp.
Xenis, OH

Prepared for

Environmental Protection Agency
Washington, DC

Dec 81



U.S. Department of Commerce
National Technical Information Service
NTIS

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	3. Recipient's Accession No. PB82-201567

4. Title and Subtitle

Test Protocol: An Environmental Assessment of Refuse Thermal Processing Facilities

5. Report Date 12/18/81

6.

7. Author(s)

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8. Performing Organization Rept. No.

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10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address

U.S. EPA CWH-563
401 M. St. SW
Washington, D.C.

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

This protocol outlines a generalized approach for the evaluation of hazardous pollutant emissions from refuse thermal processing facilities. Generalized procedures for conducting trace organic sampling, support sampling, and process monitoring activities are presented. It should be emphasized that these procedures may require modification to satisfy the particular requirements of a given test program. The primary hazardous pollutants of interest in these evaluations are tetrachlorodibenzo-p-dioxins (TCDDs). Specific analytical procedures for these compounds are included in the protocol.

The primary objective of the evaluation outlined in this protocol is to provide an estimate of the average concentrations of TCDDs emitted from a facility during the test period. To this end, a 3-day sampling program has been specified under the direction of the Environmental Protection Agency Office of Solid Waste (EPA/OSW) to provide a data base similar to that used by federal regulatory agencies in establishing compliance regulations.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
	20. Security Class (This Page)	22. Price

PB82-201567

EPA Report Number
December 1981

AN ENVIRONMENTAL ASSESSMENT OF REFUSE THERMAL PROCESSING FACILITIES

U.S. EPA Contract Number 68-01-6071

Project Officer

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FOREWORD

This report presents a generalized test protocol for conducting an environmental assessment of refuse thermal processing facilities. The protocol was developed and subsequently implemented at three test facilities under Environmental Protection Agency (EPA) Contract No. 68-01-6071. The report was prepared by Mr. Gregory Higgins, Project Leader, of SYSTECH Corporation, Xenia, Ohio.

The protocol outlines the trace organic sampling, support sampling, and process monitoring activities involved in conducting an environmental evaluation. It also specifies detailed procedures for the analysis of tetrachlorodibenzo-p-dioxins (TCDDs).

ABSTRACT

This protocol outlines a generalized approach for the evaluation of hazardous pollutant emissions from refuse thermal processing facilities. Generalized procedures for conducting trace organic sampling, support sampling, and process monitoring activities are presented. It should be emphasized that these procedures may require modification to satisfy the particular requirements of a given test program. The primary hazardous pollutants of interest in these evaluations are tetrachlorodibenzo-p-dioxins (TCDDs). Specific analytical procedures for these compounds are included in the protocol.

The primary objective of the evaluation outlined in this protocol is to provide an estimate of the average concentrations of TCDDs emitted from a facility during the test period. To this end, a 3-day sampling program has been specified under the direction of the Environmental Protection Agency Office of Solid Waste (EPA/OSW) to provide a data base similar to that used by federal regulatory agencies in establishing compliance regulations.

CONTENTS

Foreword iii
Abstract iv
Figures vii
List of Abbreviations viii
Acknowledgments ix

1. Introduction 1
   Test objective 1
   Test program participants 2
   Test plan 2
   Experimental design 2
   Test results 6
   Protocol organization 6

2. Trace Organic Sampling Activities 7
   Introduction 7
   Primary fuels 7
   Auxiliary fuels 7
   Bottom ash 8
   Control device particulate 8
   Daily compositing 8
   Final compositing 8
   Bulk Sampling Procedures 8
   Modified Method 5 sampling program 8
   Combustion air sampling program 12

3. Support Sampling Activities 21
   Introduction 21
   Particulate mass and size distribution 21
   Chlorides and Metals Analysis 21
   Hydrocarbons 21

4. Process Monitoring Activities 23
   Introduction 23
   Mass rates 23
   Gas composition sampling 23
   Data recording and reporting 24
   Temperature measurements 24
   Plant operational data 24

5. Field Team Personnel Assignments 25

CONTENTS (continued)

6. Trace Organic Analytical Procedures 27
Preparation of samples for analysis 27
Analytical procedures for TCDD 31

Appendices

A. Trace Organic Cleaning Procedures 36
B. Hydrocarbon Sampling/Analysis Procedures 39
C. Field Quality Assurance Procedures 42
D. Sample Chain of Custody Procedures 43
E. Safety Program 49
F. Procedures Manual for Modified Method 5 52
G. Data Sheets 62

FIGURES

Number		Page
1	Modified Method 5 train	10
2	Schematic of sorbent trap	11
3	Modified Method 5 sample recovery	13
4	Postsampling Modified Method 5 cleaning procedures	14
5	Resin collection system	16
6	Combustion air resin collection system--sample recovery	17
7	Combustion air sampler	18
8	Combustion sampling program--cleaning procedures	20
9	Schematic of seven-stage cascade impactor sampling train	22
10	Field position test assignments	25
11	Proposed personnel assignments	26

TABLES

Number		Page
1	Field Measurements for Environmental Evaluation	3
2	Samples for TCDD Analysis	28
3	Priorities for Sample Analysis for TCDD	32
4	List of Materials Used	33

LIST OF ABBREVIATIONS

AA	--atomic absorption
amu	--atomic mass units
BP	--boiling point
cfm	--cubic feet per minute
CFR	--Code of Federal Regulations
DMP	--dioxin monitoring program
EP	--extraction procedure
EPA/OSW	--Environmental Protection Agency, Office of Solid Waste
FID	--flame ionization detector
GC	--gas chromatograph
GC/HRMS	--gas chromatography/high resolution mass spectrometry
GC/MS	--gas chromatography/mass spectrometry
ICP	--inductively coupled plasma
MM5	--Modified Method 5
MRI	--Meteorology Research Incorporated
m/z	--atomic mass/charge
NDIR	--nondispersive infrared
ppm	--parts per million
ppt	--parts per trillion
Ps	--initial gas pressure
scf	--standard cubic feet
TCDD	--tetrachlorodibenzo-p-dioxins

ACKNOWLEDGMENTS

This test protocol was developed by SYSTECH Corporation under Environmental Protection Agency (EPA) Contract No. 68-01-6071. The EPA project officer was Randolph Chrismon of the Office of Solid Waste, Washington, D.C.

On behalf of SYSTECH Corporation, the author is pleased to acknowledge the guidance and support of Mr. Chrismon. In addition, the author is grateful to Dr. Brenda Kimble, University of California, Davis, and Dr. Michael Gross, University of Nebraska, Lincoln. These two scientists provided expert guidance in the preparation of sections of this protocol relevant to trace organic sampling and analysis.

SECTION 1

INTRODUCTION

TEST OBJECTIVE

The objective of this test protocol is to establish a generalized approach for the evaluation of hazardous pollutant emissions from refuse thermal processing facilities. This approach will include the collection of samples and data necessary to characterize the solid, liquid, and gaseous process streams of the facility. The primary pollutants of interest in this evaluation are the trace organic compounds tetrachlorodibenzo-p-dioxins (TCDD). A limited program will also be conducted during the testing period to evaluate plant operations and other emissions of interest, all of which are indicated below.

Since this protocol is meant to be applicable to any waste burning facility, specific plans addressing all of the potentially required monitoring activities at a given facility cannot be developed at this time. As an alternative to this approach, this test protocol will present a plan representative of the types of activities which might be required in any evaluation. Specific plans relevant to each test facility will be developed as required.

In order to achieve the test objective, it is anticipated that sampling and analysis of the following types of process streams may be required.

1. Primary fuels--trace organic analysis.

2. Auxiliary fuels--trace organic analysis.

3. Gaseous and particulate emissions--continuous monitoring for NO_x, SO_x, CO_2, O_2, and CO; analysis of trace organic, volatile hydrocarbon, trace metal, and chlorine emissions; and particle mass rate and sizing.

4. Bottom ash--Extraction Procedure (EP) toxicity test* and trace organic analysis.

5. Control device particulate--EP toxicity test, trace metals analysis, and trace organic analysis.

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* See Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, U.S. EPA, Office of Water and Waste Management, SW 846, May 1980.

TEST PROGRAM PARTICIPANTS

SYSTECH will conduct the field activities required for these evaluations for the Environmental Protection Agency, Office of Solid Waste (EPA/OSW). The specific procedures outlined in this protocol have been developed by SYSTECH in conjunction with testing conducted for the EPA/OSW in North Little Rock, Arkansas, and Mayport, Florida (see An Environmental Assessment of the North Shore Energy Facility, North Little Rock, Arkansas, and An Environmental Assessment of the Naval Station Heat Recovery Incinerator at Mayport, Florida, prepared under EPA Contract No. 68-01-6071). SYSTECH will also be responsible for the performance of all analyses for EP toxicity and for trace metals by inductively coupled plasma (ICP) emission spectroscopy and atomic absorption (AA) spectroscopy. These analyses will be conducted by SYSTECH in cooperation with a local testing laboratory.

The analysis of samples for TCDDs will be conducted by Dr. Michael Gross, Department of Chemistry-Mass Spectrometry, University of Nebraska, Lincoln. Dr. Gross will conduct all sample extractions for TCDD analysis according to procedures included herein and developed by Dr. Brenda Kimble, Laboratory for Energy-Related Health Research, University of California (UC), Davis, in cooperation with SYSTECH under EPA Contract No. 68-01-6071. Dr. Gross will also perform all sample cleanup procedures and gas chromatography/high resolution mass spectrometry (GC/HRMS) analyses for TCDDs. Procedures relevant to the work to be conducted by Dr. Gross are also included in this protocol.

TEST PLAN

Sampling will be conducted over a 3-day test period during which time the facility will be operated under normal conditions by plant personnel. SYSTECH will conduct all environmental testing at the facility. All elements to be sampled, including sampling frequencies and methodologies, are indicated in Table 1. Each of these elements is discussed in more detail below.

EXPERIMENTAL DESIGN

This test program is not intended to precisely quantify, in a statistically rigorous manner, the amounts of hazardous pollutants being emitted from the facility. Such an effort would require either an intensive, long-term sampling program or a valid theory of hazardous pollutant formation in an incinerator upon which one could base reasonable estimates of mean concentrations and variabilities of emissions. Because of the limited resources and time available for this test program, a definitive test is beyond the scope of the present level of effort.

This test program, as outlined in this document, must therefore be interpreted as a limited characterization of the average concentrations of hazardous pollutants being emitted from the facility during the sampling period. The 3-day sampling program specifically described in this protocol has been designed under the direction of the EPA/OSW to provide a data base similar to that which has historically been used by federal regulatory

TABLE 1. FIELD MEASUREMENTS FOR ENVIRONMENTAL EVALUATION

Measurement number	Stream sampled	Measurement required	Sample size	Frequency	Measurement method
1	Municipal waste	Hourly feed rate	NA	As charged	Load cell digital accumulator
2	Other primary fuels	Hourly feed rate or daily consumption	NA	As charged or hourly	Load cell digital accumulator or flow meter
3	"	Trace organics	*	Once	GC/HRMS
4	Auxiliary fuels	Daily consumption	NA	Hourly	Flow mater
5	"	Trace organics	1 liter	Once	GC/HRMS
6	Bottom ash	Daily production	NA	As removed	Truck weights
7	"	Trace organics	1.5 kg	Three daily composite samples + bulk sample	GC/HRMS
8	"	EP toxicity	1.5 kg	Three daily composite samples	Gas chromatography/atomic absorption (GC/AA)
9	"	Moisture	1.5 kg	Three daily composite samples	Drying oven
10	Control device ash	Daily production	NA	As removed	Truck weights
11	"	Trace organics	1.5 kg	Three daily composite samples + bulk sample	GC/HRMS

* See Section 2 for comment on sampling solid fuels.

(continued)

TABLE 1. (continued)

Measurement number	Stream sampled	Measurement required	Sample size	Frequency	Measurement method
12	Control device (continued)	Trace metals	1.5 kg	Three daily composite samples	ICP/AA emission spectroscopy
13	"	EP toxicity	1.5 kg	Three daily composite samples	GC/AA
14	Boiler outlet	Temperature	NA	Hourly	Temperature recorder
15	"	CO_2	NA	Continuous	Nondispersive infrared (NDIR) analysis
16	"	O_2	NA	Continuous	Theta sensor
17	"	CO	NA	Continuous	NDIR
18	"	NO_x	NA	Continuous	Theta sensor
19	"	SO_x	NA	Continuous	Theta sensor
20	Stack	Temperature	NA	2 per day	Modified Method 5 (MM5) data
21	"	Moisture	NA	2 per day	MM5 data
22	"	Volume/velocity	NA	2 per day	Pitot tube traverse
23	"	Particulate emissions	>60 scf†/ run	3 runs per test	Method 5
24	"	Particle sizing	~20 scf	1 per day	Meteorology Research Inc. (MRI) impactor

† Standard cubic feet.

(continued)

TABLE 1. (continued)

Measurement number	Stream sampled	Measurement required	Sample size	Frequency	Measurement method
25	"	CO_2	NA	Continuous during stack sampling runs	NDIR
26	"	Hydrocarbons	2 liters	2 per day	GC/Flame ionization detector (FID)
27	"	Trace organic sampling (MM5)	16 m^3 (8 m^3 per train)	1 per day	GC/HRMS
28	"	Trace metals	$\geq$30 scf	3 runs per test	ICP/AA emission spectroscopy
29	Facility	Operating conditions	NA	Hourly	Monitor operating instrumentation
30	Combustion air	Trace organics (resin collection system)	25 m^3	1 per day	GC/HRMS
31	"	Trace organics (Hi-Vol system)	800 m^3	1 per day	GC/HRMS

agencies in establishing compliance regulations. This data base will also provide information similar to that used by the air pollution control industry in the design of control devices.

TEST RESULTS

SYSTECH will prepare a final report containing the data obtained during the test program. This information will be presented in a format suitable for incorporation into the developing data base on the trace compound emissions from refuse thermal processing facilities.

PROTOCOL ORGANIZATION

This protocol is organized into five separate sections discussing the sampling activities, process monitoring activities, field team personnel assignments, and trace organic analytical procedures planned for the test. Sampling activities will include two separate subsections; the first is dedicated to trace organic sampling and the second to additional support sampling activities. The third section will include process monitoring activities required to characterize the facility operation. Personnel assignments are included in this protocol as the fourth section. The fifth section will include extraction and analytical procedures for TCDDs. Included as appendices to this document are the trace organic cleaning procedures (Appendix A), hydrocarbon sampling/analysis procedures (Appendix B), field quality assurance procedures (Appendix C), sample chain of custody procedures (Appendix D), the field safety program (Appendix E), a procedures manual for the Modified Method 5 train (Appendix F), and data sheets (Appendix G).

SECTION 2

TRACE ORGANIC SAMPLING ACTIVITIES

INTRODUCTION

The trace organic sampling procedures specified in this test protocol represent the best available methodologies as determined by the EPA/OSW. There are three specific trace organic sampling efforts to be conducted. First, primary and auxiliary fuels, bottom ash, and collection device particulates will be sampled according to general procedures developed by SYSTECH and Dr. Brenda Kimble under EPA Contract No. 68-01-6071. Second, stack samples will be obtained with a Modified Method 5 train incorporating an XAD-2 sorbent resin trap. This effort will be performed by following a modification of the procedures specified by TRW Environmental Engineering Division in "Pilot Test Program--Chicago Northwest Incinerator Boiler No. 1," EPA Contract No. 68-02-2197 (project officer, Michael Osborne). Dr. Kimble has also assisted SYSTECH in developing the modifications to this program and in establishing a quality assurance program for maintaining the overall quality of trace organic sampling procedures. Third, a program will be conducted to characterize the trace organic composition of the combustion air. Sample coding procedures for all trace organic samples are indicated in Appendix D. All data sheets pertinent to these sampling activities are included in Appendix G.

PRIMARY FUELS

Because of the extreme heterogeneity and difficulties in obtaining representative samples of municipal solid waste, this program does not include a plan to sample the municipal waste for trace organic analysis. If other primary fuels more amenable to representative sampling procedures are burned at the facility, they will be sampled and analyzed for trace organic composition. The specific procedures for sampling these fuels will be developed as required. For example, 1-ℓ samples of liquid fuels will be taken from each storage tank used during the test program. These samples will be collected in amber glass bottles cleaned using the procedures noted in Appendix A and stored in the dark for subsequent trace organic analysis.

AUXILIARY FUELS

One 1-ℓ sample of liquid auxiliary fuel will be taken from the storage tanks during the test program. This sample will be collected in an amber glass bottle cleaned using the procedures noted in Appendix A and stored in the dark for subsequent trace organic analysis.

BOTTOM ASH

Samples of bottom ash will be taken for EP toxicity analysis and trace organic analysis by cone and quartering a sample diverted from the ash storage container. Two samples (500-mℓ volume) will be collected three times daily with a stainless steel scoop and put into tared 500-mℓ amber glass jars. One set of samples will be weighed and stored in the dark until the end of the test day for compositing. The other set of samples will be weighed on tared drying pans to the nearest 1 gram and dried to a constant weight in a drying oven (103° to 110°C).

CONTROL DEVICE PARTICULATE

Samples of control device particulate will be taken for EP toxicity analysis and trace organic analysis by cone and quartering a sample diverted from the collection system. Three samples (500-mℓ volume) will be collected each day with a stainless steel scoop and put into tared 500-mℓ amber glass jars. The samples will be weighed and stored in the dark until the end of the test day for compositing. This set of samples will also be examined for metals content (see Section 3).

DAILY COMPOSITING

Bottom ash samples and control device particulate samples will be composited by weight at the end of each daily test period. This compositing will be accomplished by transferring a weighed 500-g aliquot from each of the three daily samples into a 2-ℓ amber glass bottle.

FINAL COMPOSITING

At the end of the 3-day test period, the three daily samples of bottom ash and control device ash will be composited by weight into individual final samples of each of these process streams. The same compositing scheme as noted above will be followed.

BULK SAMPLING PROCEDURES

Bulk samples will be taken from the bottom ash and control device particulate to provide "reservoir" samples for potential future analytical work. The samples will be collected in daily quantities (~10-ℓ volume) over the 3-day test period. Samples will be collected with stainless steel scoops in 50-ℓ Teflon bags and stored inside a large plastic garbage can with the bags tightly sealed. The total weight of the bags will be determined at the end of each collection period.

MODIFIED METHOD 5 SAMPLING PROGRAM

SYSTECH will conduct the sampling of stack particulate fractions and gases for subsequent trace organic analysis with two Modified Method 5 trains. Each train will be modified to incorporate an XAD-2 resin cartridge for trace

organic adsorption. General train preparation, operation, and sample recovery procedures have been developed from those specified in the TRW Environmental Engineering Report (EPA Contract No. 68-02-219F). A detailed procedures manual for the Modified Method 5 train has been developed by SYSTECH and is included in Appendix F. The XAD-2 sorbent resin will be prepared by SYSTECH as described in "IERL/RTP Procedures Manual: Level 1 Environmental Assessment," second edition, EPA publication 600/F-78-201 (see Appendix A).

Modified Method 5 Train Description

The Modified Method 5 train shown in Figure 1 is designed for the collection of particulates and volatile matter from ducts and stacks. A sample is collected through a glass lined probe heated to 121°C and then passed through a heated particulate filter (Reeve Angel 934AH). Vaporous material conducted through the filter is carried by Teflon tubing to a water cooled XAD-2 sorbent resin trap. This trap is illustrated in Figure 2. Cold water from the impinger ice bath is pumped through the jacket of the trap to maintain a gas outlet temperature $\leq$20°C. Gas exiting from the resin trap is conducted by Teflon tubing into a bank of four ice cooled impingers. The first impinger in the train contains 100 mℓ of glass distilled HPLC grade water for condensate trapping, the second and third are condensate overflow reservoirs, and the final impinger contains ~500 grams of silica gel to prevent the entry of moisture into the pump.

Modified Method 5 Operating Conditions

Identical MM5 sample trains will be operated simultaneously on the stack to provide a combined daily sample volume of approximately 16 m^3 (565 scf).

The Modified Method 5 trains will be leak checked before and after each testing period according to the Code of Federal Regulations (CFR) 40 Method 5 procedures. Because the trains sample at a rate of approximately 1 ft^3/min (cfm) (28 ℓ/min), a 5-hr sampling program will be required to obtain the 16-m^3 sample. This factor, together with the logistical difficulties of duplicate simultaneous sampling of the same stack, necessitates a deviation from commonly employed traverse procedures. The sampling program will be conducted by placing the two probes at 90° angles in two of the stack access ports and traversing each across the stack diameter. This will be accomplished by completely inserting one probe and inserting the other probe just inside the stack at the beginning of the test run. The probes will then be traversed until their respective penetrations are exchanged at the end of 5 hours. Standard CFR 40 Method 5 procedures will be followed as closely as possible in all respects.

Modified Method 5 Sampling Duration and Frequency

Sampling will be conducted with two trains on 3 days during the test period. The trains will be operated for a period of approximately 5 hours each day until 16 standard m^3 (565 scf) have been sampled.

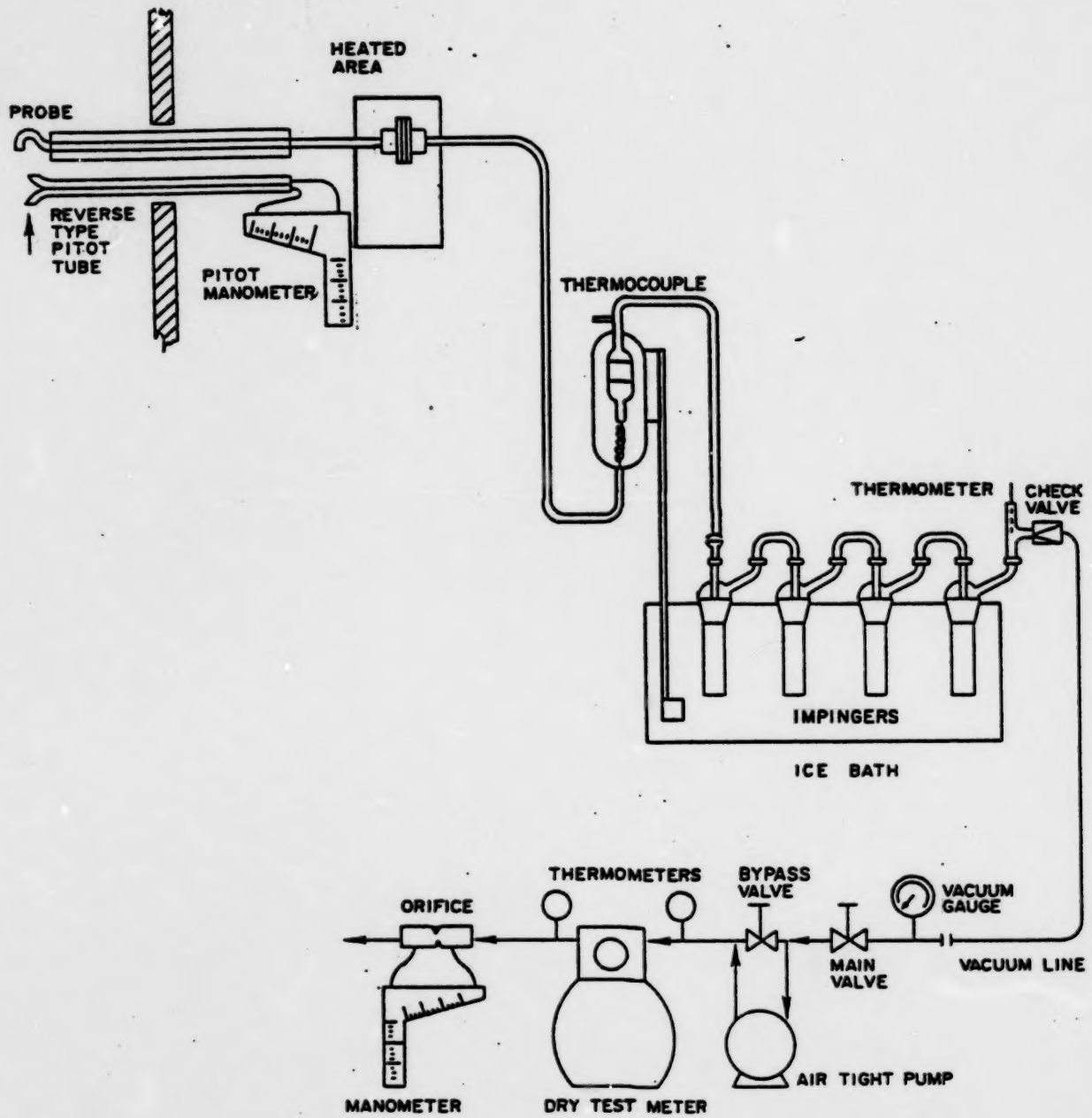


Figure 1. Modified Method 5 train.

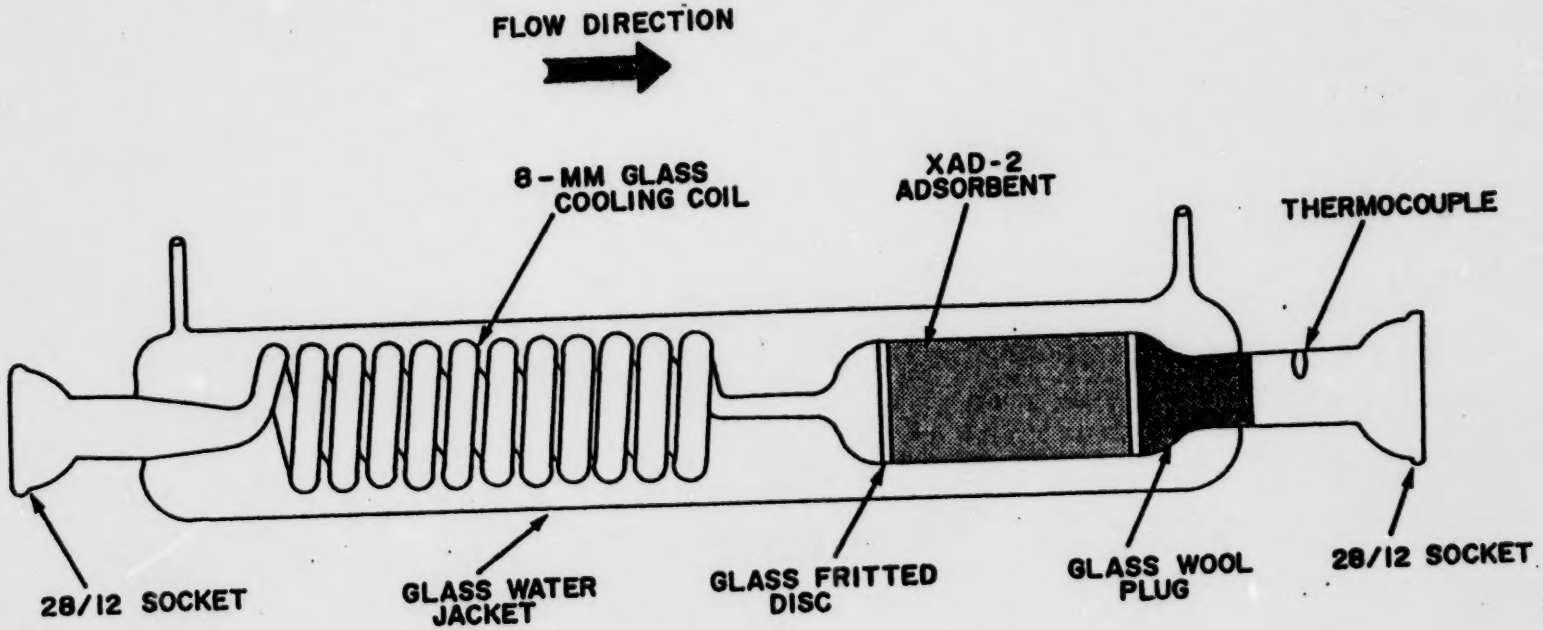


Figure 2. Schematic of sorbent trap.

Modified Method 5--Method Blank

In order to characterize the contribution of the sampling train to the collected sample, a method blank will be collected using MM5. The sampling train will be assembled and leak checked in the area designated for sample recovery. A cartridge containing activated charcoal will be attached to the intake of the train in order to provide a clean air sample. Sampling will be conducted in the same manner as that followed for stack sampling; the train will be operated for a period of 5 hr at a sampling rate of 1 cfm (28 ℓ/min) to obtain a sample of 8 m^3 (28 ft^3). Samples will be recovered from this method blank as noted below for the stack sampling program.

Collection and Transfer of Modified Method 5 Samples

The operation of the Modified Method 5 train results in three types of samples: particulates (3-P), resin (3-XR), and condensate (3-I). These samples and the associated rinsings will be collected as three discrete samples as indicated in Figure 3. For the purpose of analysis, fractions 3-XR and 3-I will be combined and treated as one sample (see Section 6). SYSTECH will transport the samples acquired in the Modified Method 5 program by express shipment to the analytical group for subsequent analyses.

Postsampling Modified Method 5 Cleaning

Cleanup of the Modified Method 5 train after sample recovery will be performed as shown in Figure 4 if visual inspection indicates the need for cleaning beyond the sample recovery procedure.

COMBUSTION AIR SAMPLING PROGRAM

Introduction

The goal of this program is to characterize the combustion air in terms of its trace organic composition. SYSTECH will employ two sampling methods which represent the most appropriate approach for the goals of this program. With the first method, vaporous trace organics will be collected with a sampling train incorporating an XAD-2 resin trap followed by a bank of impingers for condensate collection. Particulates and trace organic compounds adsorbed to these particles will be collected by the second sampling method on a glass fiber filter with a General Metal Works Hi-Vol sampler. Samples will be collected and stored in amber glass bottles cleaned using procedures noted in Appendix A. The sample coding scheme for these samples is described in Appendix D.

These methods are designed to collect samples similar to those derived from the Modified Method 5 trains used in the source sample collection program. Compounds collected from the combustion air will therefore be directly comparable with those sampled from the facility emissions.

Since this combustion air sampling program is essentially a research oriented effort, there are no guidelines directly applicable to the

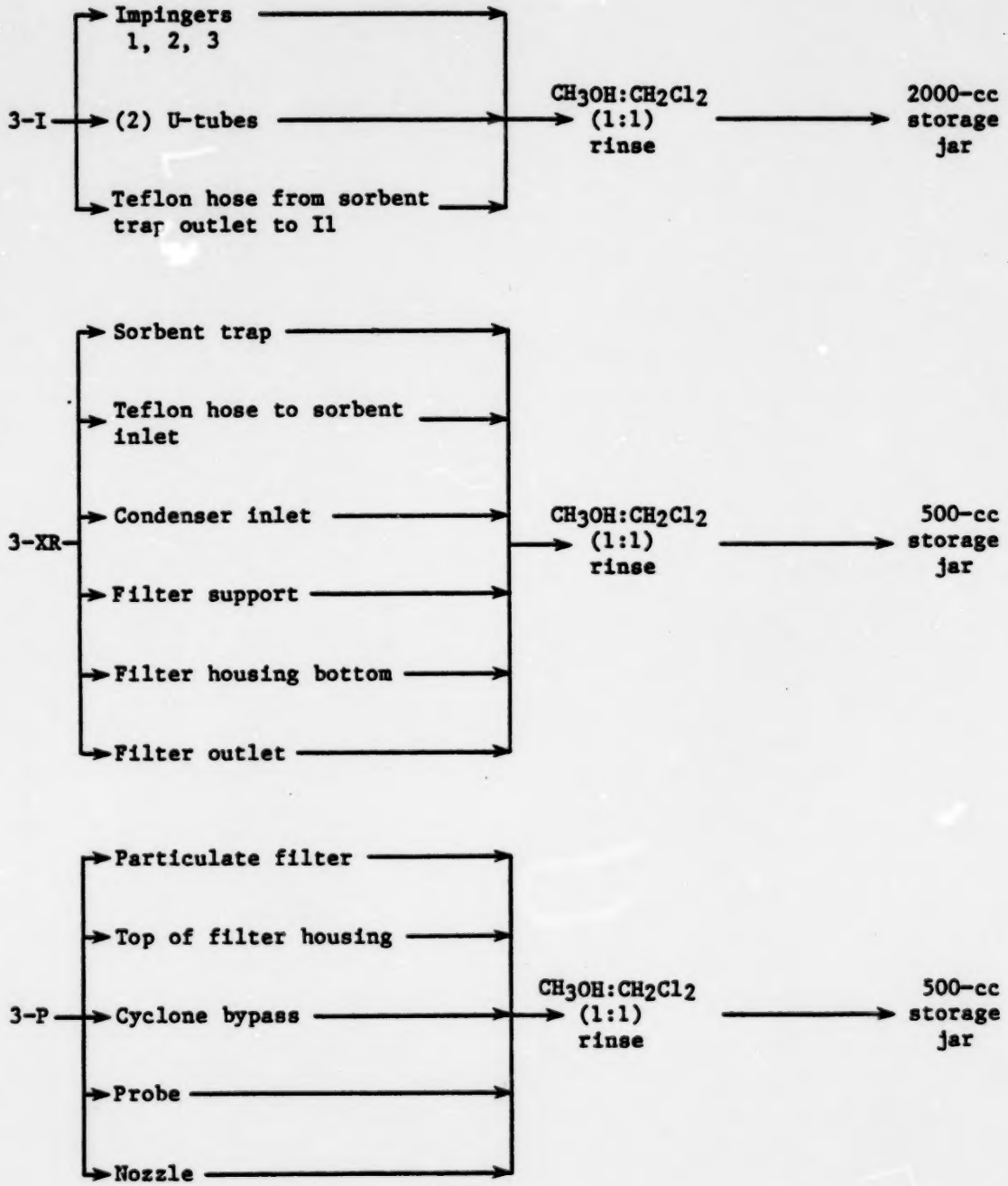


Figure 3. Modified Method 5 sample recovery.

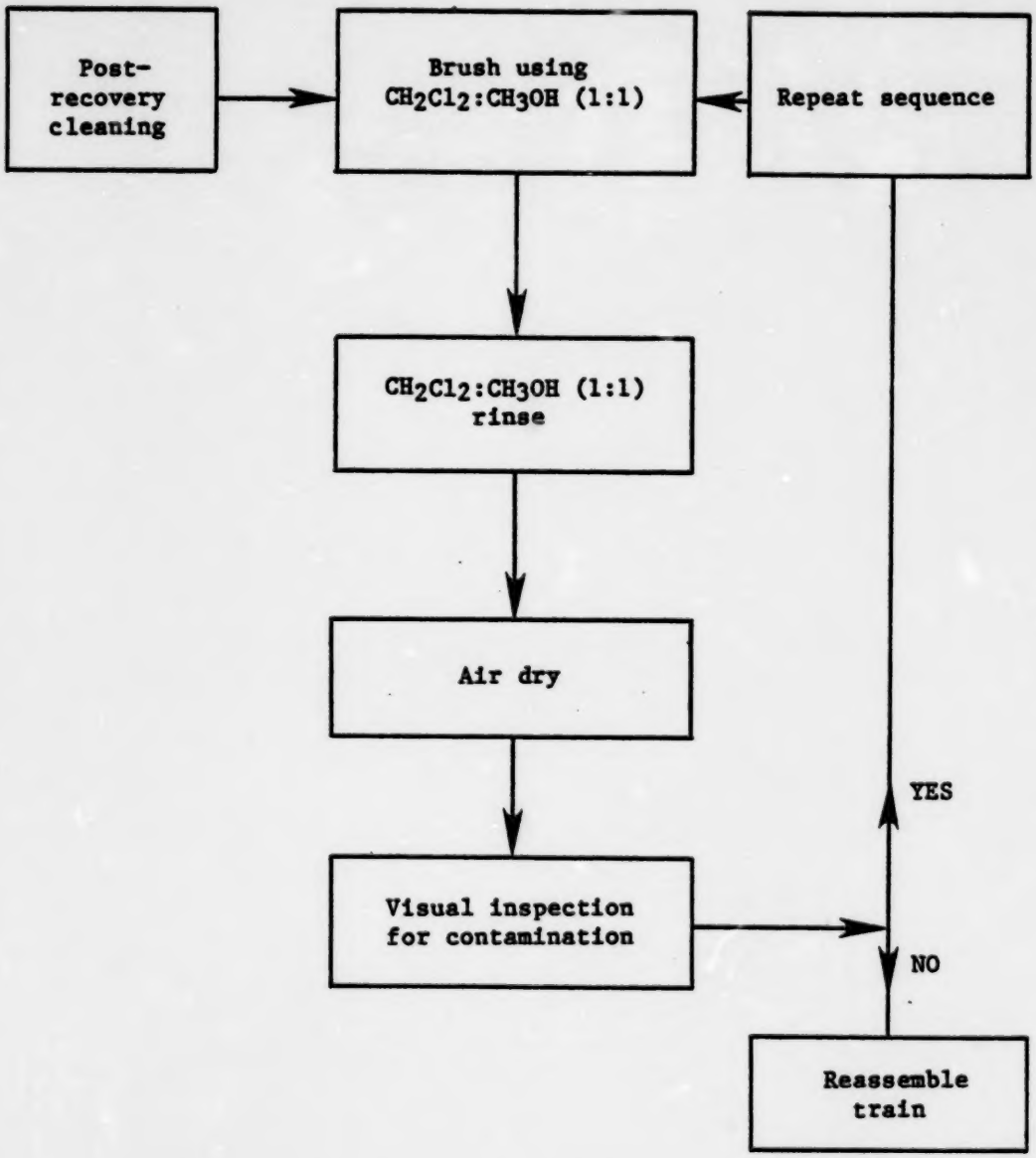


Figure 4. Postsampling Modified Method 5 cleaning procedures.

determination of required sample sizes and sampling frequencies. This program will therefore parallel the source sampling program in the sense that sample sizes and sampling frequency will be maximized within the time frame of the source testing program. Both sampling systems will therefore be operated for 24 hours during each testing day in order to obtain as large a sample as possible. The objective of this approach is to provide data which will indicate whether trace organic compounds of interest are present at measurable concentrations in the combustion air.

Sampling Methods

Resin Collection System--

Combustion air samples will be collected during each day of the source testing program with a resin collection system (see Figure 5). The system will consist of a water cooled resin trap (as shown in Figure 2) charged with 20 grams of XAD-2 resin, backed up with a system of four Method 5 type impingers connected with Teflon tubing. The first and second impingers will each contain 100 mℓ of HPLC grade water, the third will be empty, and the fourth will contain silica gel for protection of the pump.

The sampling train will be constructed of glass, Teflon, or stainless steel only. The train and resin will be cleaned by the procedures noted in this test protocol. During operation of the sampling train, the temperature of the resin trap and impingers will be maintained at $\leq$20°C by a recirculating ice bath system. All components will be covered with aluminum foil to prevent photo-decomposition of any collected materials.

The sampling train will be leak checked before and after testing. Sampling will be conducted for a 24-hr period during each stack sampling day. The train will be operated at a sampling rate of 0.5 cfm to obtain a total collected volume of 720 ft^3 (25 m^3).

At the completion of testing, samples will be recovered in two fractions as noted in Figure 6. The first fraction (labeled 4-XR) will contain the resin and rinsings of the trap; and the second (labeled 4-I) will contain the impinger solutions, condensate, and associated rinsings. Both samples will be placed in cleaned amber glass bottles and stored in the dark for subsequent analysis. For the purpose of analysis, these two fractions will be combined and treated as one sample (see Section 6).

Hi-Vol Sampling System--

Combustion air samples will also be collected during each day of the source testing program with a General Metals Works Hi-Volume sampler fitted with an 8- × 10-in. glass fiber particle filter (see Figure 7). The filter and filter holder will be thoroughly rinsed with CH_2Cl_2:CH_3OH (1:1) before sampling is initiated.

Sampling will be conducted for a 24-hr period during each stack sampling day. The Hi-Vol sampler will be operated at a nominal rate of 20 cfm for a total collected volume of 29,000 ft^3 (816 m^3). If particulate loading

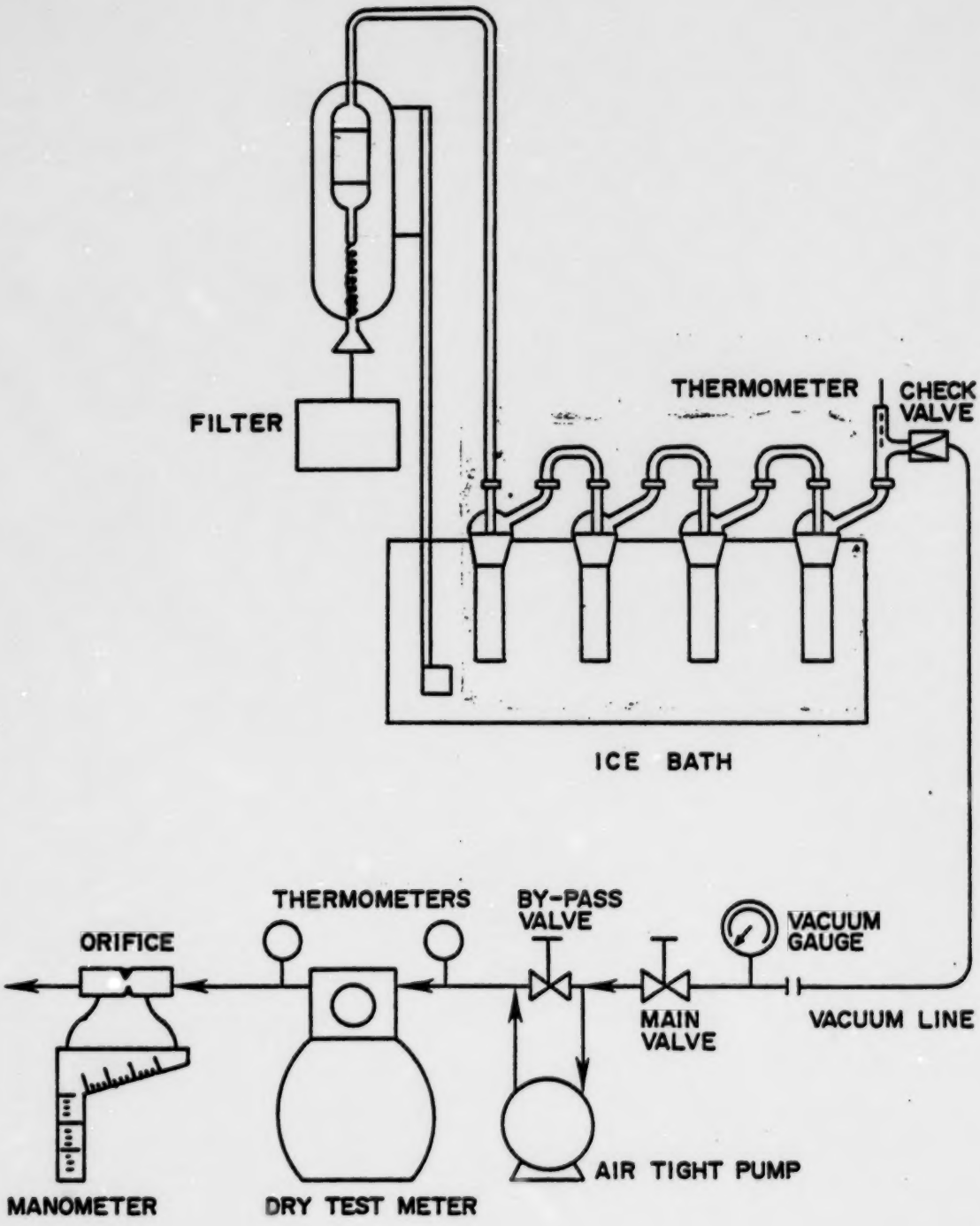


Figure 5. Resin collection system.

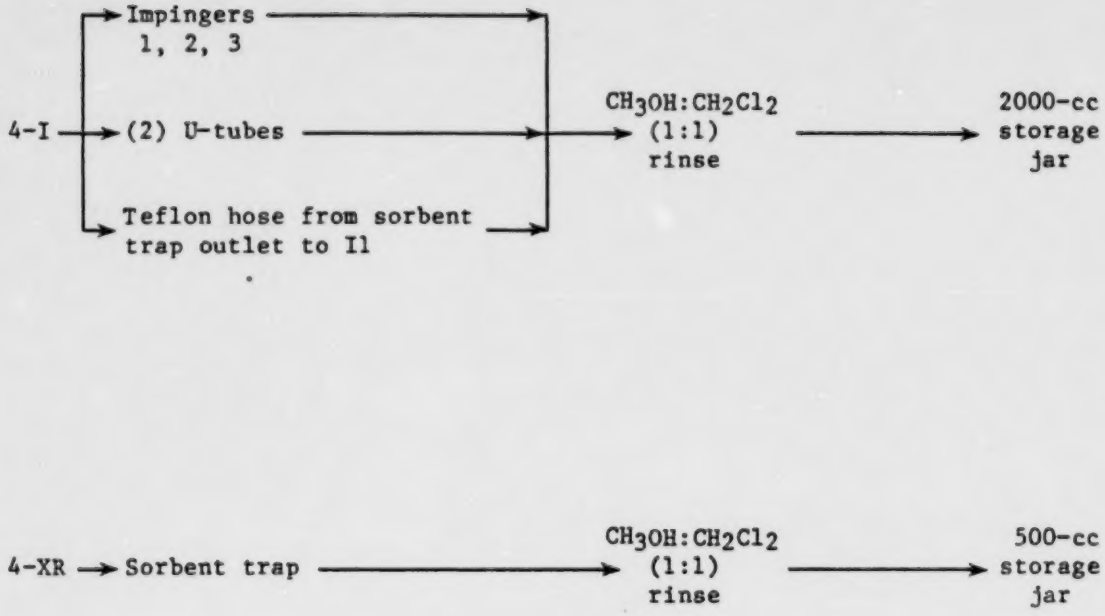


Figure 6. Combustion air resin collection system--sample recovery.

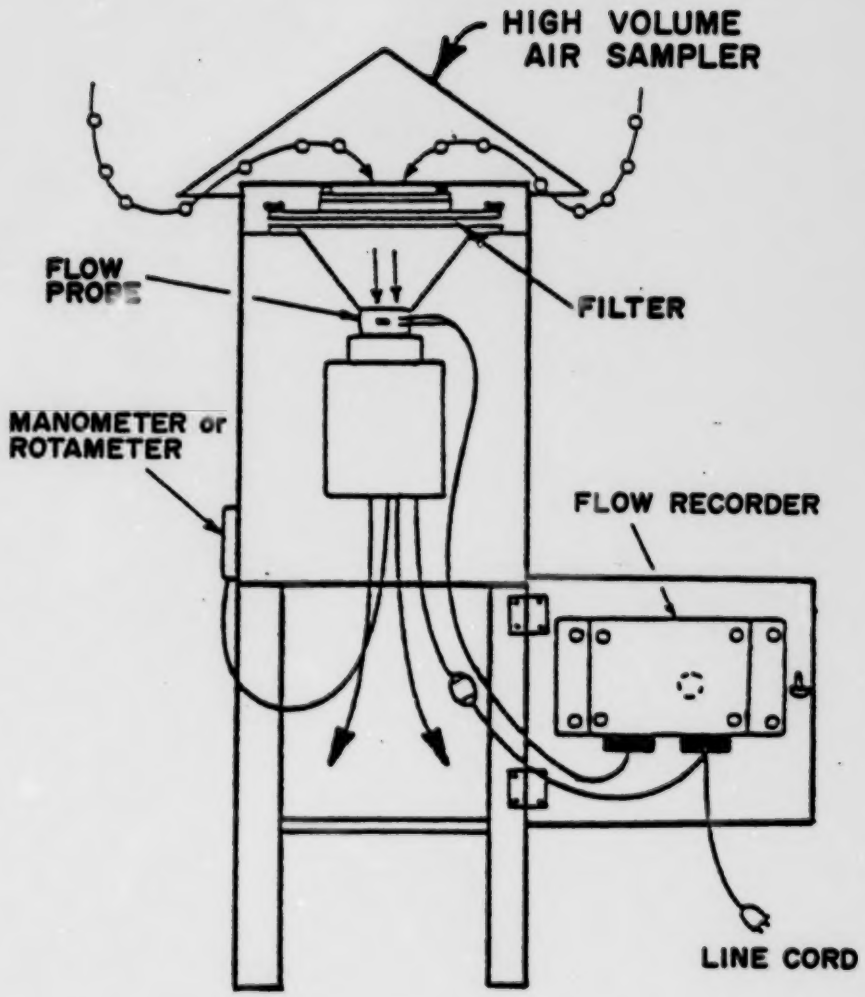


Figure 7. Combustion air sampler.

prevents the acquisition of this sample volume, sampling will be terminated at or before 24 hours with the volume obtained in that time.

At the completion of sampling, the filter will be removed from the holder. It will then be placed in an amber glass bottle and stored in the dark for subsequent trace organic analysis.

Location of Sampling Systems

Both sampling systems will be placed as near as possible to the combustion air intake into the facility. Since the goal of this program is to characterize the actual combustion air, no attempt will be made to eliminate the entry of recirculated stack gases, plant dust, etc., into the sampling trains. This approach should not be interpreted as an ambient sampling program. It has not been designed to characterize the environment surrounding the facility.

Postsampling Cleaning Procedures

After sample collection, both systems will be thoroughly cleaned to remove all traces of the previous sample and other contaminants. The general procedures for this cleaning are indicated in Figure 8.

Sampling Method Blanks

In order to characterize the contribution of the sampling trains to the collected sample, method blanks will be collected with both the resin collection and Hi-Vol systems.

Resin Collection System--

The resin collection system will be assembled in the area designated for sample recovery. A cartridge containing activated charcoal will be attached to the intake of the train in order to provide a cleaned air sample. Sampling will be conducted at a rate of 0.5 cfm for 24 hours to obtain a total collected volume of 720 ft^3 (25 m^3). Samples will be recovered from this method blank as noted above for the combustion air samples.

Hi-Vol Sampling System--

Because of the difficulties involved in providing a large volume clean air sample to the Hi-Vol system, it will not be operated for the collection of the method blank. Instead, the system will be assembled in the area designated for sample recovery and then immediately broken down for sample recovery. The sample will be recovered from this method blank as noted previously for the Hi-Vol combustion air samples.

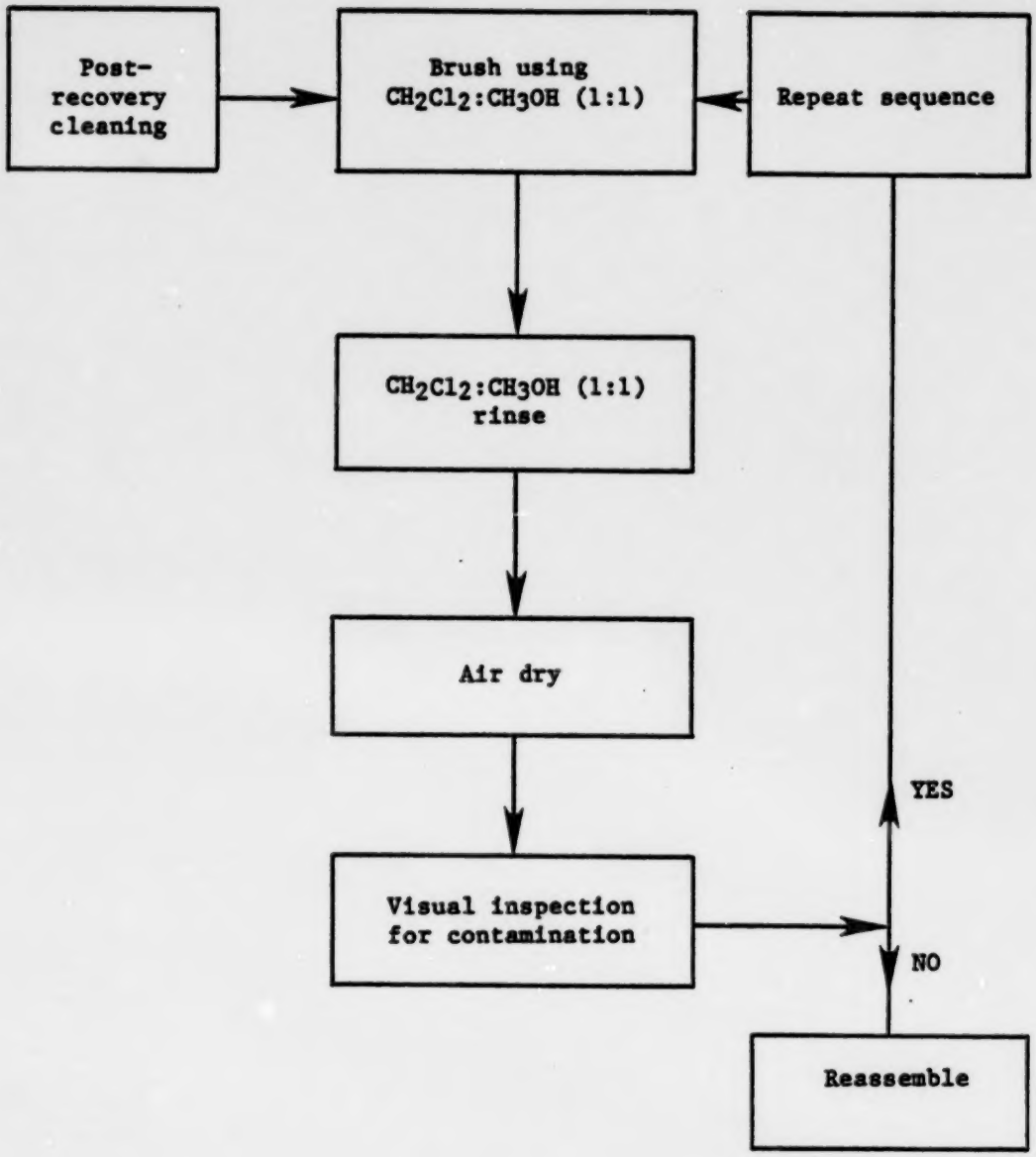


Figure 8. Combustion sampling program--cleaning procedures.

SECTION 3

SUPPORT SAMPLING ACTIVITIES

INTRODUCTION

To provide supporting data for the trace organic sampling program, additional sampling will be conducted to characterize the process operation. This sampling effort will consist of particle mass rate and size determination of stack emissions; hydrocarbon, chlorine, and metals determination of stack emissions; and metals determinations of control device particulate. Data sheets pertinent to these sampling activities are included in Appendix G.

PARTICULATE MASS AND SIZE DISTRIBUTION

The particle mass emission rate will be determined with three standard CFR 40 Method 5 runs conducted during the test. The filters, probe washes, and impinger solutions from these trains will be analyzed for chlorides and metals as indicated below.

A Meteorology Research Incorporated Inertial Cascade Impactor (see Figure 9) will be used to determine stack particulate size. Seven collection stages yield seven size fractions spanning "greater than 30" to less than "0.4 microns." The particulate sample is collected and sized aerodynamically in the stack at isokinetic conditions. Particle sizing will be conducted once each day according to the procedures specified in the MRI instruction manual.

CHLORIDES AND METALS ANALYSIS

The presence of chlorides and metals will be determined on the filters, probe washes, and impinger solutions from three CFR Method 5 runs obtained during the test program. Metals will be determined by ICP emission spectroscopy and by AA spectroscopy (if so directed by the project officer). In addition, control device particulate, collected as indicated in Section 2, will be subjected to metals analysis by ICP emission spectroscopy and by AA spectroscopy (if so directed by the project officer).

HYDROCARBONS

Hydrocarbon emissions from the stack will be assessed via gas chromatography (GC) with a flame ionization detector (see Appendix B). Sampling and analysis periods will be conducted twice daily during each day of the test period. Samples will be collected as grab samples from the stack and analyzed in terms of total concentrations and percent composition in six boiling ranges between -160°C to +90°C.

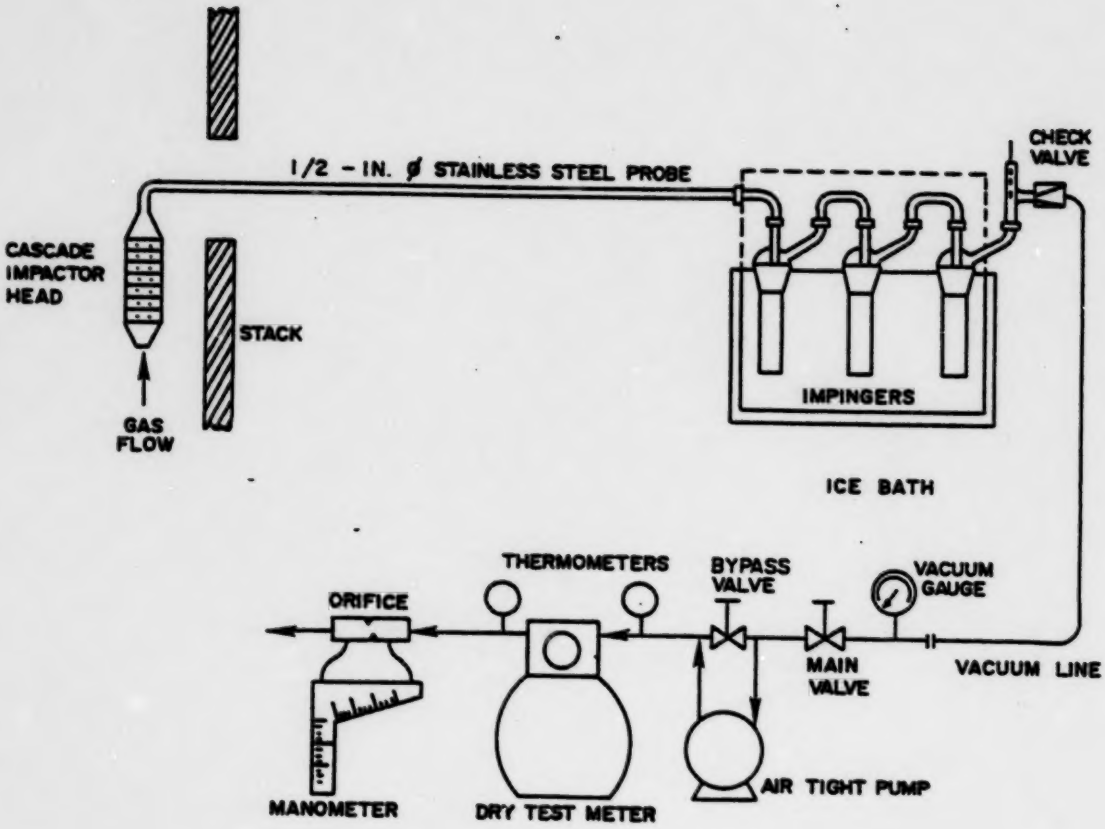


Figure 9. Schematic of seven-stage cascade impactor sampling train.

SECTION 4

PROCESS MONITORING ACTIVITIES

INTRODUCTION

Plant operational data will be recorded during the sampling program to provide additional information for this evaluation. The elements to be included in this effort are mass rates of refuse, other primary fuels, auxiliary fuels, bottom ash, and control device particulates; gas composition; and facility operating conditions. Data sheets pertinent to these elements are included in Appendix G.

MASS RATES

The mass flow of refuse into the facility will be monitored and recorded. Consumption of other primary and auxiliary fuels will be monitored by reading the appropriate flow meters. Bottom ash (wet) and control device particulates will be monitored by recording the truck weights of these materials as they are removed from the process line for disposal. Boiler feed water and blowdown water flow rates will be monitored by existing flow meters.

GAS COMPOSITION SAMPLING

The composition of the stack flue gases emitted to the atmosphere will be monitored continuously for CO_2, CO, SO_x, NO_x, and O_2. The stack gases will be drawn from the boiler outlet and the stack and will be conditioned prior to entering the analytical instruments by removing the particulate matter and water vapor via a sintered metal filter and an ice bath condensing chamber.

CO_2 and CO

Carbon dioxide and carbon monoxide levels in the flue gas will be monitored during the daily test periods with Beckman Model 864 Infrared Analyzers. Within each analyzer, two equal energy infrared beams are directed through two optical cells, a flow-through sample cell, and a sealed reference cell. Solid state electronic circuitry continuously measures the difference between the amount of infrared energy absorbed in the two cells. This difference is a measure of the concentration of the component of interest in the sample stream.

O_2, SO_x, and NO_x

The remaining gaseous emissions of interest will be monitored on a Theta Sensor Source Monitor, Series 7213, Model 1940. This instrument will monitor O_2, SO_x, and NO_x simultaneously through the use of three separate electrochemical transducers connected in series. The principle of operation of this instrument is based on the combined use of a semipermeable membrane and selective oxidation-reduction reactions within completely sealed electrochemical transducers. The electrical signals generated by these transducers are directly proportional to the concentrations of the gases being monitored. The response is linear over the entire analytical range.

Calibration

After the instruments are set up at the field test site and every 24 hours during the 72-hr test period, each instrument will be subjected to a multipoint calibration consisting of a zero gas nitrogen (N_2), a calibration gas which is roughly equivalent to a 90 percent of scale reading, and no less than one calibration gas in the midscale range. This multipoint calibration will establish the validity of the instrument response curves and will also serve as an operational check of the instrument. A morning and evening zero span calibration procedure will be employed to verify that no significant changes in instrument response have occurred during the test period. The instrument response obtained on these morning and evening calibrations will be averaged to obtain a daily calibration correction factor which will be applied to the data recorded during that day for each instrument.

DATA RECORDING AND REPORTING

The electrical outputs from the continuous monitoring instruments will be channeled to a Leeds & Northrup SPEEDO-MAX® W Multipoint Strip Chart Recorder with a six channel capability. The trace for each instrument will be analyzed for maximum reading, minimum reading, and the mean of all 15-min points during the test period for that day.

TEMPERATURE MEASUREMENTS

The exhaust gas temperature will be measured continuously at the boiler outlet location using a Type-K thermocouple and continuously recorded on a multipoint recorder. Readings will be taken on an hourly basis as part of the hourly plant tour.

PLANT OPERATIONAL DATA

Temperatures, air flows, and pressures of the combustor will be recorded hourly from the readout of existing equipment at the facility. Boiler feed water temperatures and steam pressure will be monitored to determine the output of the heat recovery boiler.

SECTION 5

FIELD TEAM PERSONNEL ASSIGNMENTS

The individual tasks of the work program at the test facility have been grouped together by field position assignments. These assignments are shown in Figure 10.

The SYSTECH staff has been assigned to the field position as shown in Figure 11. These staff members will be responsible for the individual tasks as assigned in Figure 10.

Position	Test
Field chemists	1. Two/day hydrocarbons 2. One/day SO_x, NO_x, O_2, CO_2, CO 3. Two/day impinger solution preparation 4. One/day MRI preparation 5. Two/day ambient conditions
Stack crew chief and stack technician	1. Two/day Modified Method 5 2. Six/day orsat 3. One/day MRI 4. Three/test Method 5
Process monitor	1. Hourly readings 2. Daily ash sample 3. Waste oil, fuel oil, and refuse samples 4. Daily fly ash sample 5. Sample log and storage
Field team leader	1. Field preparation on site 2. Field team lodging and transportation 3. Field team supervision 4. Test coordination 5. Technical review

Figure 10. Field position test assignments.

Position title

A. Field team leader

- ultimate field responsibility/authority
- personnel supervision
- technical supervision/review
- test coordination/administration

B. Field chemists

- technical supervision/review
- instrumentation
  - calibration
  - maintenance
- field analytical
  data control
- sample control
- execute hydrocarbon testing
- recover trace organic samples

C. Stack crew chief

- assist with stack tests
- operate equipment
- record data
- coordinate stack Method 5, Modified Method 5, and MRI tests

D. Stack technician

- execute stack Method 5, Modified Method 5, and MRI tests

E. Process monitor

- miscellaneous duties
- data recording assistance
- sample collection assistance

Figure 11. Proposed personnel assignments.

SECTION 6

TRACE ORGANIC ANALYTICAL PROCEDURES

PREPARATION OF SAMPLES FOR ANALYSIS

Samples will be prepared for TCDD analysis by the procedures indicated below. These procedures have been developed by Dr. Brenda Kimble and SYSTECH under EPA Contract No. 68-01-6071.

General Procedures

All samples will be handled and stored using procedures that will ensure the integrity of the samples for trace organic analysis. Glass materials will be cleaned by soaking overnight in concentrated chromic acid followed by rinsing with glass distilled water and a 1:1 (by volume) mixture of CH_2Cl_2: CH_3OH followed by oven drying. Teflon and metal materials, as well as aluminum foil, will be cleaned using the CH_2Cl_2:CH_3OH solvent mixture. Cleaned materials will be protected from extraneous materials by wrapping with solvent cleaned aluminum foil and using Teflon lined screw caps where appropriate.

Extraction of Samples for TCDD Analysis

A list of the samples which may be analyzed for TCDD is presented in Table 2 together with a reference number for the extraction procedure, the quantity to be extracted, and a note relating to additional handling to be undertaken. It is anticipated that one train of 1 days MM5 run will be analyzed first and that further analyses will be determined by the outcome of this analysis.

The internal TCDD standard will be provided by Dr. Michael Gross from a previously tested batch provided by the EPA Dioxin Monitoring Program (DMP) Project Officer, Mr. M. L. Dellarco. The concentration, total volume, solvent, and the amount to be used will be specified by Dr. Gross.

All extracts will be concentrated on a rotary evaporator and/or by slow evaporation under a stream of dry purified nitrogen and transferred to cleaned glass ampules. The ampules containing the organic extracts will be sealed under vacuum and kept in the dark in a refrigerator until analysis.

TABLE 2. SAMPLES FOR TCDD ANALYSIS

Number	Sample type	Description	Extraction method	Quantity to be extracted	Notes
1	Process streams	Primary fuels	3	10 grams	(b)
2	"	Auxiliary fuels	3	10 grams	(b)
3	"	Bottom ash	2	10 grams	(a,b)
4	"	Control device particulate	1	10 grams	(a,b)
5	Stack samples (MM5)	Total particles	4	1 sample from 1 train	(c)
6	"	Total condensate and resin	5	1 sample from 1 train	(c)
7	"	Total impingers, condensate, and resin	5	1 days run	(b,c)
8	(Hi-Vol system)	Filter	1	1 days run	(b,c)
9	Sampling controls (Containers)	Container blank--lab	6 a	2 of each container type, extracts composited	
10	"	Container blank--field	6 a	2 of each container type, extracts composited	
11	(Solvents)	Solvent 1: CH_2Cl_2:CH_3OH	6 b	1 gal	
12	"	Solvent 2: HPLC water	6 c	100 mℓ	
13	(MM5--lab blank)	Total particles	4	1 run	(b)
14	"	Total condensate and resin	5	1 run	(b)

(continued)

TABLE 2. (continued)

Number	Sample type	Description	Extraction method	Quantity to be extracted	Notes
15	(MM5--lab blank)	Total impingers, condensate, and resin	5	1 run	(b)
16	(Combustion air-- Hi-Vol system)	Filter	1	1 run	(b)
17	(Materials)	Method 5 strain filter	1	2 composited	(b)
18	"	Hi-Vol filter	1	2 composited	(b)
19	"	Resin blank	1	100 g/lot	(b)
	Analytical controls				
20, 21, and 22	Solvent check (3)	Solvent and spike, no procedure	Concentration		
23 and 24	Solvent blank (2)	Solvent, no spike, no procedure	Concentration		
25, 26, and 27	Method check (3)	Solvent, no spike, and procedure	Concentration		
28, 29, and 30	Control samples (3)	Media, spike, and procedure	1	10 grams (coal fly ash)	(d)

Totals: 30 Analyses (no replicates)
8 Samples
11 Analytical controls (1 out of every 3 samples processed)
11 Sampling controls

Notes: (a) 1500 grams composite from SYSTECH.
(b) Hold all samples until first Method 5 train stack samples are evaluated.
(c) Hold remaining Modified Method 5 runs pending analysis; may be used for replicate analysis.
(d) Reference - B. J. Kimble and M. L. Gross, Science 207, 59 (1980); samples found negative for 2,3,7,8-TCDD and co-eluting isomers (detection limit 0.6 parts per trillion (ppt).

Extraction Method 1--

See Table 2 for samples to be extracted by this method. These samples will be spiked with isotopically-labeled TCDD and extracted with 1:1 (by volume) CH_2Cl_2:CH_3OH using an ultrasonic probe. The TCDD internal standard spiking solution will be syringed together with the container rinsings onto the surface of the solid sample or filter and the solvent allowed to evaporate. The extraction solvent will then be added in an appropriate volume to permit efficient extraction. This volume will vary depending on the density of the material; the analytical controls will be of a comparable or larger volume. The samples will be extracted using appropriate precautions to ensure that the extracting solvents are not heated excessively as a result of the ultrasonic treatment. Each extraction will be followed by centrifugation and removal of the organic extracts, and the pooled extracts will be concentrated.

Extraction Method 2--

These samples will be extracted using an ultrasonic probe as in Method 1. However, as these samples are expected to contain some moisture, it is necessary to use an additional step after most of the solvent has been removed on the rotary evaporator. This step will involve the addition of an appropriate quantity of an additional solvent in order to remove the water by azeotropic distillation. This azeotroping solvent will then be evaporated so that the extracted material is taken just to dryness; the sample will then be redissolved in an appropriate quantity of 1:1 CH_2Cl_2:CH_3OH.

Extraction Method 3--

It is not possible at this time to predict exactly whether or not the primary and auxiliary fuels will completely dissolve in 1:1 CH_2Cl_2:CH_3OH. A quantity of solvent will be added to a 10-g aliquot of the fuel, and the mixture will be shaken. A visual inspection will then be made to determine whether there are two distinct layers or just a solution in the solvent. Either the organic extract or the diluted fuel will be sealed in ampules and stored for analysis.

Extraction Method 4--Total Particles from Modified Method 5 Train--

The total particles from the MM5 train are comprised of the probe rinsings, the control device sample, and the particles on the filter. These samples will be collected in more than one container, and the probe rinsings will consist of particles and an as yet unknown quantity of solvent (1:1 CH_2Cl_2:CH_3OH). The samples will be composited from one of the Method 5 trains for 1 day only, the day and train to be specified by SYSTECH. This composited sample will have the internal standard spike added to one of the filters. As the total solvent volume to be added by SYSTECH is dependent on the ease of removing the particles from the probe and the connecting lines, the extraction method cannot be specified at this time. The ultrasonic probe method for extraction is proposed followed by centrifugation or filtration to obtain the pooled organic extract.

Extraction Method 5--Resin and Condensate--

It is anticipated that the resin extract and the condensate extract will be composited to provide a single sample for TCDD analysis. The TCDD internal

standard spike will be added to the resin itself, and the resin will be extracted using an ultrasonic probe. The solvent extract will then be processed as in Method 2.

Extraction Method 6--

1. Container controls will be spiked with a solution of the internal standard, and the solvent will be allowed to evaporate to deposit the standard on the walls of the container. The containers will then be extracted three times with an appropriate volume of 1:1 (by volume) CH_2Cl_2:CH_3OH, and the extracts will be pooled.

2. The solvent control (1 gal of 1:1 [by volume] CH_2Cl_2:CH_3OH) will be spiked with the internal standard in the original container and concentrated on a rotary evaporator and/or with a stream of clean, dry nitrogen.

3. The water control (100 mℓ of HPLC grade water) will be spiked with the internal standard and extracted three times with an equal volume (100 mℓ) of 1:1 (by volume) CH_2Cl_2:CH_3OH by shaking in a Teflon lined, screw cap jar for 2 hours. The solvent layer will be pipetted off, combined, and concentrated.

Priorities for TCDD Extractions and Analyses

It is proposed that the samples be analyzed for TCDD according to the priorities and analytical results as listed in Table 3. Assuming that the analyses listed in Table 2 do, in fact, answer the questions regarding TCDD emissions, the remaining samples will be made available for potential analysis of other organic constituents.

ANALYTICAL PROCEDURES FOR TCDD

Sample Preparation

The samples will be subjected to cleanup by liquid extraction and then sodium carbonate, alumina, and florisil chromatography. A list of materials required for these procedures is shown in Table 4. Dr. Gross has provided these procedures and the analytical procedures that follow.

The content of the ampules will be transferred to a beaker and evaporated under dry N_2, replacing the CH_2Cl_2:CH_3OH with hexane. The hexane will then be transferred to a 125-mℓ separatory funnel, and additional fresh hexane will be used to rinse the sides of the beaker. The rinse will also be transferred to the separatory funnel. The hexane will be extracted twice with 25 mℓ of 1.0 normal potassium hydroxide, followed by one extraction of 25 mℓ of distilled water, and then washed with aliquots of concentrated H_2SO_4 (approximately 10 mℓ each) until the hexane and acid layers are clear. The hexane layer will then be washed with 50 mℓ of water, and excess acid will be neutralized by addition of small amounts of solid Na_2CO_3 to the water/hexane mixture until the neutralization reaction subsides.

TABLE 3. PRIORITIES FOR SAMPLE ANALYSIS FOR TCDD

Priority	Sample number*	Sample type
1	5 and 6	MM5 total particles MM5 total condensate and resin
	9 and 10	Container controls
	11 and 12	Solvent controls
	25	Method check
	28	Control sample
	Await satisfactory results before proceeding	
2	13 and 14	MM5 lab blank
	26	Method check
	20	Solvent check
	17 thru 19	Sampling controls--materials
	29	Control sample
	Await satisfactory results before proceeding	
3	1 thru 4	Process stream samples
	7 and 8	Combustion air samples
	21	Solvent check
	27	Method check
	23	Solvent blank
	15 and 16	Combustion air sampling controls
	Await satisfactory results before proceeding	
4	5 and 6	Replicates from 5 remaining runs
	22	Solvent check
	24	Solvent blank
	30	Control sample

* See sample number designations in Table 2.

TABLE 4. LIST OF MATERIALS USED

Benzene--Omnisolv,* MCB
Carbon tetrachloride--Omnisolv, MCB
Hexane--Omnisolv, MCB, nonultraviolet absorbing
Methylene chloride--Omnisolv, MCB
Sulfuric Acid, concentrated--analytical reagent, Mallinckrodt
Water--distilled in glass
Aluminum oxide-neutral, Activity Grade I, Woelm Pharma
Florisil, 60-100 mesh, Fisher
Potassium hydroxide--analytical reagent, Mallinckrodt
Sodium carbonate (anhydrous)--analytical reagent, Fisher
Sodium sulfate (anhydrous)--analytical reagent, Fisher
Dry nitrogen (boil-off from liquid N_2)

* All Omnisolv line solvents are distilled in glass, suitable for chromatography and residue analysis.

Sodium carbonate columns will be prepared by adding anhydrous Na_2CO_3 to a height of 8 cm in 25-mℓ burettes. The burettes will be plugged with a generous amount of glass wool to prevent Na_2CO_3 leakage (Na_2CO_3 is not to be packed tightly). The column will be wetted with hexane before transferring the hexane layer from the separatory funnel, followed by a rinse of 25 mℓ of hexane. All eluate will be collected in 4-oz jars and then concentrated under a stream of dry nitrogen to approximately 1 mℓ.

Alumina will be washed by saturation with methylene chloride, followed by removal of excess solvent and activation at 225°C for at least 24 hours. The column will be cooled to room temperature in a desiccator before use. A 5-cm column will be prepared using a disposable pipette plugged with a small amount of glass wool. The alumina will be capped with 1/4-cm anhydrous sodium sulfate to remove water.

Hexane will be used to wet the column before transferring the sample, dissolved in 1-mℓ hexane, to the column. A second 1 mℓ of hexane will be used to rinse the jar and then will be added to the column. The alumina will be eluted with two 3-mℓ portions of CCl_4, then with 4 mℓ of CH_2Cl_2. These solvents will be used to rinse the jars before being transferred to the column. The methylene chloride fraction will be collected in a 2-oz jar and again concentrated under nitrogen to 1 mℓ while replacing the volatile CH_2Cl_2 with hexane. All other fractions can be discarded.

The final step will be florisil chromatography. The florisil will be saturated with methylene chloride and activated in an oven at 165°C for 24 hours. The packing will then be allowed to cool in a vacuum desiccator. A

5-cm column will be prepared in a disposable pipette plugged with glass wool. The column will be packed with 10 mℓ of hexane under light nitrogen pressure in an attempt to remove all air pockets.

The sample, dissolved in 1 mℓ of hexane, will be added to the florisil column. The container will then be rinsed with 1 mℓ of 8 percent (by volume) methylene chloride in hexane. The column will be eluted with 9 mℓ of 8 percent CH_2Cl_2 in hexane (which will remove 80 to 85 percent of the polychlorinated biphenyls (PCBs) and then with 8 mℓ of CH_2Cl_2. The dichloromethane fraction, which contains the TCDD, will be collected in a centrifuge tube and the solvent evaporated to a small volume under a stream of dry nitrogen. The sides of the centrifuge tube will be rinsed down with 1 mℓ of hexane and the volume again reduced. The tube will be rinsed a final time with 1 mℓ of hexane and the solvent evaporated until the volume is less than 100 µℓ. The centrifuge tube will be capped with a Teflon lined screw cap and stored in a freezer at about -20°C until analysis.

Gas Chromatography/High Resolution Mass Spectrometry Analysis

At the time of analysis, the side of the centrifuge tubes will be washed thoroughly with approximately 100 µℓ of hexane or isooctane using a graduated syringe. During the washing the solvent will be allowed to evaporate until a volume of ~50µℓ remains. This remaining volume will be accurately measured; usually three-fourths will be replaced in the centrifuge tube, and the one-fourth remaining in the syringe will be used for the gas chromatography/mass spectrometry (GC/MS) analysis.

Mass Spectrometer--

A Kratos MS-5076 ultra high resolution mass spectrometer will be used for this analysis (ultimate resolution = 180,000). The mass spectrometer is interfaced via a direct coupling to a Perkin Elmer Sigma II gas liquid chromatograph. Data acquisition will be accomplished with a Nicolet 1170 signal averaging computer.

Gas Chromatography--

The column will be a 6 ft × 1/4 in o.d. glass containing a Dow mixed phase packing. Typical operating conditions are: Helium flow rate of 25cc/min; injector 175°C; and column temperature program at 210°C, ramped at 10°C/min to 300°C, and held there until the dioxin has eluted. The GC/MS interface is a simple, glass lined, stainless steel capillary and is held at an average temperature of 250°C. Typical retention time is 4.5 minutes (peak width at 10 percent height approximately 50 seconds).

Mass Spectrometer Conditions--

The electron impact source will be used at 70 eV ionizing energy and an accelerating voltage of 8 kV. The source will be set at 250°C. The instrument will be tuned to a resolving power of 10,000 (10 percent valley definition).

Data will be acquired using the standard ion switching feature provided with the MS-50 (dual ion monitoring). The first analysis will be made

monitoring one channel atomic mass/charge (m/z) 321.8936 (the most abundant molecular ion of TCDD having natural isotopic elemental abundances) and m/z 333.9339 ($^{13}C_{12}$--TCDD--the internal standard) on the second channel. The complete peak profiles will be acquired at a bandwidth of 3000 Hz by scanning of a frequency of about 2 Hz, corresponding in each case with a mass range of 300 parts per million (ppm) (0.096 atomic mass units [amu]). The output of the mass spectrometer will be accumulated over about 75 sweeps per channel using a Nicolet Model 1170 signal averager. The resulting signals will be submitted to a three-point smoothing routine prior to print out on an X-Y recorder.

Calculation of Results--

Quantitation will be achieved by employing the internal standard "ratio method." Throughout the analysis period, standard samples containing TCDD and internal standard will be analyzed. From these results, a calibration curve can be prepared by plotting the ratio of the weights of TCDD and internal standard versus the ratio of signal intensities (intensity at m/z 321.8936; intensity at m/z 333.9339). Residues of TCDD in actual samples will be obtained by measuring the ratio of the signal intensities at m/z 322 and at 334 (internal standard) and reading the concentration of TCDD from the calibration plot. The detection limit in the actual samples will be obtained by multiplying the noise level by 2.5 which is considered the maximum amount of TCDD which could be present in the sample. The percent recovery will be measured using the absolute signal intensity for the internal standard and mass spectrometer response factors measured by analyzing standard solutions of internal standard.

Validation--

Samples which show detectable concentrations of TCDD or which are questionable will be reanalyzed by removing a second aliquot and reinjecting into the GC/HRMS. For this validation, the high mass channel is centered at 321.8936 and the low mass channel at 319.8965, the second most abundant molecular ion for natural TCDD. All other conditions will be as reported above. The theoretical ratio expected for TCDD is 0.77 (m/z 319.8965:m/z 321.8936).

The analysis permits calculation of a concentration of TCDD from the absolute signal intensity observed at m/z 321.8936 using response factors determined for the mass spectrometer from analysis of standard solutions of TCDD. Based on the percent recovery measured above, the results are adjusted to 100 percent recovery. Validation of TCDD is considered acceptable if the observed ratio is 0.77 ±0.10.

APPENDIX A

TRACE ORGANIC CLEANING PROCEDURES

SAMPLE CONTAINER CLEANING PROCEDURES

One sample container cleaning procedure will be employed for the test program. This procedure, which applies to all sample containers, is presented in brief in Figure A-1. It has been developed by SYSTECH and Dr. B. Kimble under EPA Contract No. 68-01-6071.

1. Fill sample containers with concentrated chromic acid solution and soak overnight.
2. Rinse containers thoroughly with distilled water.
3. Rinse containers three times with HPLC grade water.
4. Rinse containers three times with CH_2Cl_2:CH_3OH (1:1).
5. Place Teflon lined lids (previously cleaned with 1:1 CH_2Cl_2:CH_3OH) on cooled containers and store in shipping containers.

Note: All solvents are of distilled in-glass grade (nanograde).

Figure A-1. Cleaning procedures: sample containers.

FILTER CLEANING PROCEDURES

All filters will be cleaned by thorough rinsing with CH_2Cl_2:CH_3OH (1:1) and stored for use in aluminum foil previously cleaned with the same solvent system.

RESIN CLEANING PROCEDURES

This material is taken from the EPA Level 1 Manual and will be followed as closely as possible in the test program.

Scope and Application

XAD-2 resin, as supplied by the manufacturer, is impregnated with a bicarbonate solution to inhibit microbial growth during storage. Both the salt solution and any residual extractable monomer and polymer species must be removed before use. The resin is prepared by a series of water and organic extractions followed by careful drying.

Extraction

EPA Method 1--

The procedure may be carried out in a giant Soxhlet extractor. An all glass thimble (55-90 mm o.d. × 250 mm deep [top to frit]) containing an extra coarse frit is used for extraction of XAD-2. The frit is recessed 10 to 15 mm above a crenulated ring at the bottom of the thimble to facilitate drainage. The resin must be carefully retained in the extractor cup with a glass wool plug and a stainless steel screen since it floats on the final solvent, methylene chloride. This process involves sequential extraction in the following order:

Solvent	Procedure
Water	Initial rinse with 1 liter H_2O for 1 cycle, then discard H_2O
Water	Extract with H_2O for 8 hours
Methyl alcohol	Extract for 22 hours
Methylene chloride	Extract for 22 hours
Methylene chloride (fresh)	Extract for 22 hours

Drying

After evaluation of several methods of removing residual solvent, a fluidized bed technique has proven to be the fastest and most reliable drying method. A simple column with suitable retainers (as shown in Figure A-2) will serve as a satisfactory column. A 10.2-cm (4-in.) Pyrex pipe 0.6 meter (2 ft) long will hold all of the XAD-2 from the Soxhlet extractor, with sufficient space for fluidizing the bed while generating a minimum resin load at the exit of the column.

EPA Method 2

High purity tank nitrogen may be used to dry the XAD-2. The high purity nitrogen must first be passed through a bed of activated charcoal approximately 150 mℓ in volume. With either type of drying method, the rate of flow should gently agitate the bed. Excessive fluidization may cause the particles to break up.

QUALITY CONTROL PROCEDURES

The quality control results must be reported for the batch. This will be accomplished by providing a portion of each batch as an analytical blank sample.

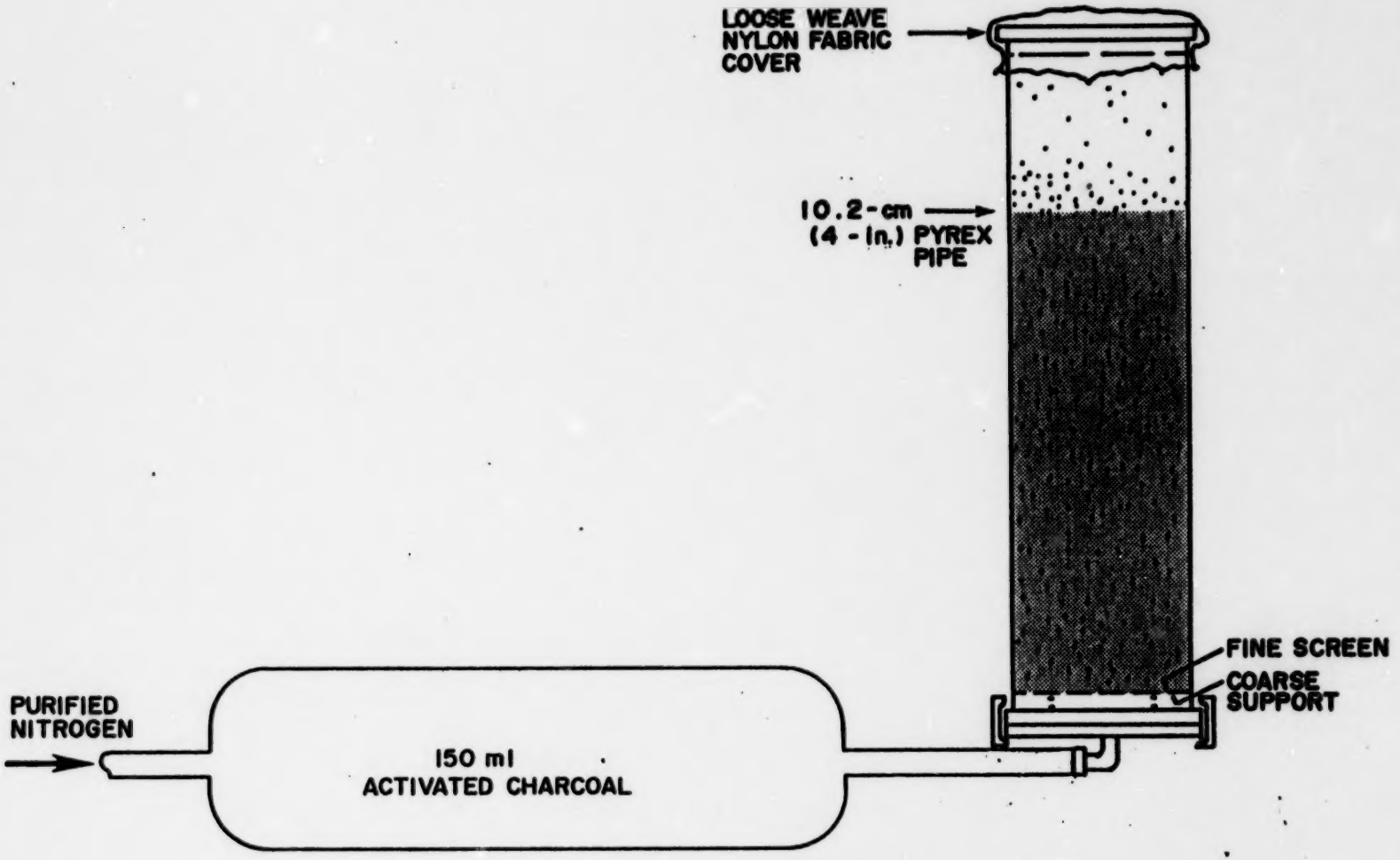


Figure A-2. XAD-2 fluidized bed drying apparatus.

APPENDIX B

HYDROCARBON SAMPLING/ANALYSIS PROCEDURES

HYDROCARBON SAMPLING

All hydrocarbon samples will be taken in glass bulbs of the dual valve, positive displacement type with 2-ℓ volume. Figure B-1 illustrates the sampling train planned for this test. Sampling will be conducted twice each day.

Supported pyrex glass of greater than 0.6 cm (1/4 in.) diameter and at least 30 cm (12 in.) in length will be used for the probe intake material. Other connective tubing to the collection vessel will be of similarly nonreactive material. At the time of sampling, the probe will be attached to the evacuated bulb and then inserted into the pressure duct for sample withdrawal.

Prior to field use, all bulbs will be leak checked. In the field, prior to sampling, the train will be leak checked.

Sampling is conducted as follows:

1. Place the probe in the stack at the sampling point, and purge the line up to the bulb with approximately 10 volumes of gas.
2. Connect the bulb and make sure connections are tight and leak free.
3. Fill the bulb with a volume of gas.
4. Adjust the bulb to atmospheric pressure.
5. Disconnect the bulb and analyze as soon as possible.

HYDROCARBON ANALYSIS

The following gas chromatograph (GC) conditions will be used for analysis.

Species	Column	Temperature and conditions	Detector
Volatile organics bp -160°C to 90°C	6 ft by 1/8 in. SS Porapak Q	Helium carrier at 20 mℓ/min. Injector temperature at 105°C, detector at 200°C. Isothermal at 60°C for 2 minutes. Increase 25°C/min to 150°C, hold for 5 minutes. Increase at 20°C/min to 170°C, hold for 6 minutes.	FID

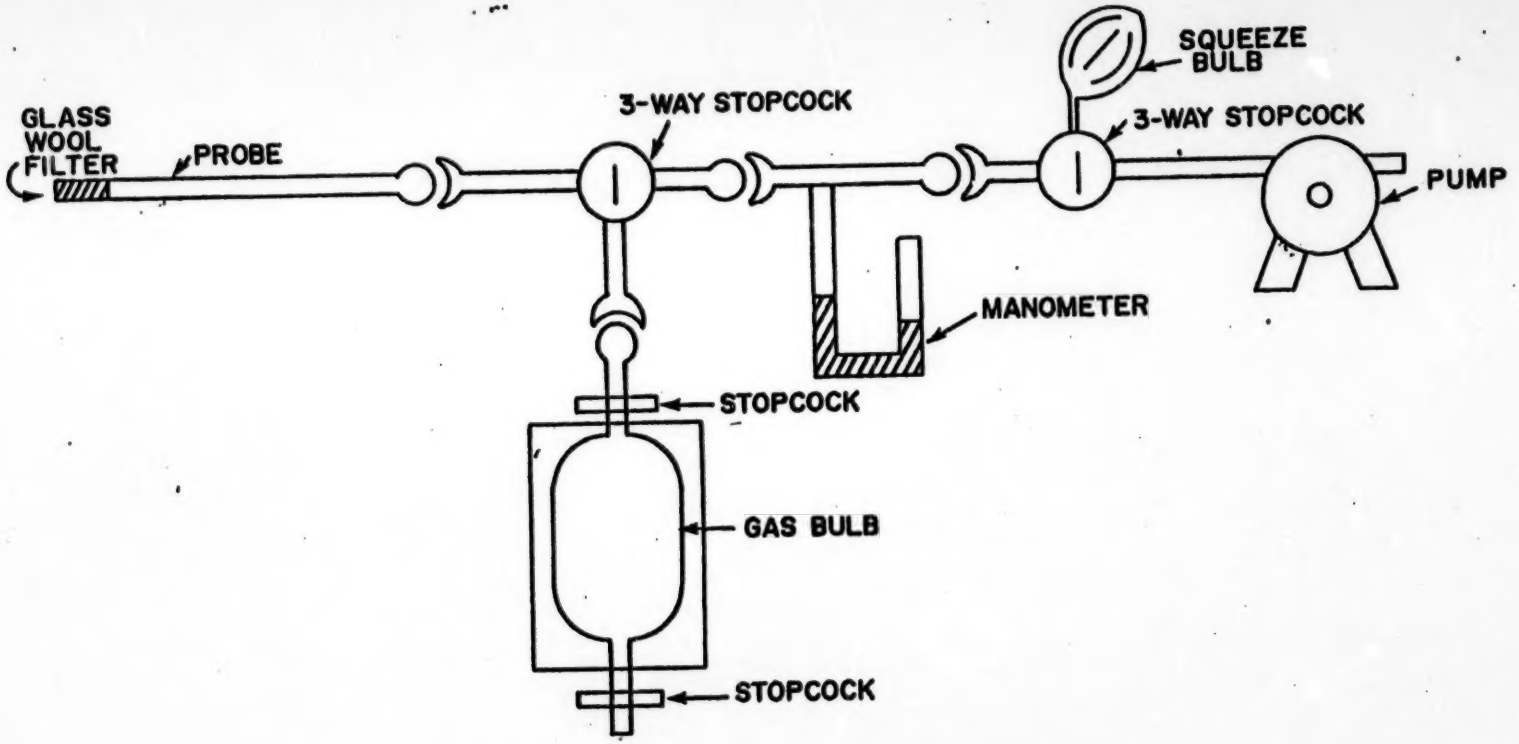


Figure B-1. Illustration of hydrocarbon sampling train.

Appropriate standardized gas samples will be used to calibrate and maintain quality assurance requirements for the GC analyses. Data will be reported as total hydrocarbon concentration observed during the analysis period and as percent composition in the six boiling ranges (-160°C to -100°C, -100°C to -50°C, -50°C to 0°C, 0°C to 30°C, 30°C to 60°C, and 60°C to 90°C).

APPENDIX C

FIELD QUALITY ASSURANCE PROCEDURES

In order to assure adequate quality control of the sampling program for trace organic analysis, a field quality assurance program will be followed for the test program. Methods used to obtain these blanks will be the same as those described in this document. Figure C-1 lists the samples, containers, and reagents involved in this program.

1. Laboratory blanks. Two of each size container will be stored in the original shipping container at SYSTECH. They will be shipped with the field samples to the analytical group and composited into one sample extract for analysis.

2. Field blanks. The same program as above will be followed, but storage will be in SYSTECH's mobile laboratory on site at the test facility.

3. Solvent blanks. One gallon of CH_2Cl_2:CH_3OH (1:1) and HPLC grade H_2O will be shipped to the analytical group for analysis.

4. Filter blanks. Two of each of the filter sizes used in this program will be shipped to the analytical group and composited into two samples for analysis.

5. Resin blanks. One hundred grams of XAD-2 resin extracted by SYSTECH will be shipped to the analytical group for analysis.

6. Lab blank: Modified Method 5. The Modified Method 5 will be operated as specified in this document at the sample recovery site. All associated samples will be recovered and sent to the analytical group for analysis.

7. Lab blank: combustion air resin system. The train will be operated as specified in this document at the sample recovery site. All associated samples will be recovered and sent to the analytical group for analysis.

8. Lab blank: combustion air Hi-Vol system. The train will be set up and recovered at the sample recovery site. The filter will be sent to the analytical group for analysis.

Figure C-1. Field quality assurance program.

APPENDIX D

SAMPLE CHAIN OF CUSTODY PROCEDURES

INTRODUCTION

In order to maintain the integrity of all samples taken at the test facility, a detailed chain of custody procedure will be followed. This procedure will be accomplished by keeping master sample log books and data sheets carefully identifying every sample taken. Shipping and receiving of samples between SYSTECH and the analytical group will be documented by signature sheets accompanying the samples being transferred. All data obtained from the analysis of samples will be presented to SYSTECH with all pertinent information necessary to interpret this data (for presentation in the final report) in terms of initial sample volumes or weights.

SAMPLE LOGS

Three separate master logs will be kept to document the samples taken at the test facility. These will consist of a nonstack sample log, a Modified Method 5 and combustion air sample log, and a log containing all remaining stack emission samples (with the exception of hydrocarbon samples which will be entered only on the appropriate data sheets). Entries in these logs will include a numerical entry number, a sample identification number, the name of the sample logger, and any pertinent comments. A sample log sheet is shown in Figure D-1. The sample identification number will be composed of the following information: date, time, name of the person sampling, and the sample code designations. The sample identification number will be prefaced by the name of the test facility and the year of testing. The type of sample will be identified according to the sample coding system shown in Figure D-2. The identification number "Facility name-80-9/10-0100-Name-3IC," for example, indicates the impinger catch from the Modified Method 5 run begun at 0100 hours on 9/10.

DATA SHEETS

Data sheets pertinent to the collection and analysis of samples are shown in Appendix G. These data sheets will remain in the custody of SYSTECH for preparation of the final report.

REAGENT LOGS

The preparation and field use of reagents will be documented in order to provide quality control and identification of appropriate reagent blanks

SAMPLE LOG

Entry number	Sample ID number	Logged by	Comments

Figure D-1. Sample log sheet.

Auxiliary fuel samples	1-FO	Combustion air samples	
Primary fuel samples	2-WA	Resin collection system resin and rinsings	4-XR
Modified Method 5 samples		impingers and rinsings	4-I
Particulate and rinsings	3-P	Hi-Vol system filter	5-F
Resin and rinsings	3-XR		
Impingers	3-I	Bottom ash samples	6-BA
		Control device particulate samples	7-CA

Note: To indicate the duplicate MM5 runs, -A or -B will follow the sample code. Sample blanks will be so designated only on the master sample log.

Figure D-2. Sample coding system.

for analysis. Figure D-3 indicates a reagent log sheet on which this information will be recorded. These sheets will be placed in each of the three master logs, and reagents made and used for the tests included in the logs will be recorded where appropriate.

ON-SITE SAMPLE STORAGE

All samples collected by SYSTECH will be securely stored and protected from light in the mobile laboratory while on site at the facility.

SAMPLE TRANSFER

All samples collected by SYSTECH will either remain in the custody of SYSTECH for subsequent analysis or be shipped to the analytical group. The transfer of custody in shipping will be accomplished by the completion of a shipping transfer form (see Figure D-4). This form will require the signature of both the shipper and the receiver. Attached to the shipping transfer form will be an invoice containing the numerical sample entry number, the designation facility name-80, and a general description of the sample type.

SAMPLE CUSTODY

Custody of samples implies that the person responsible must provide for safe storage and maintenance of records sufficient to maintain sample integrity.

Reagent Log

Reagent	Date of preparation	Prepared by	Comments	Date of use	Used by	Comments

Figure D-3. Reagent log sheet.

Shipper

Name SYSTECH Corporation

Date _____

Signature _____

Dates of custody _____

Carrier

Name _____

Date _____

Signature _____

Dates of custody _____

Receiver

Name _____

Date _____

Signature _____

Dates of custody _____

Carrier

Name _____

Date _____

Signature _____

Dates of custody _____

Receiver

Name _____

Date _____

Signature _____

Dates of custody _____

Comments

All logged samples are packed and in acceptable condition. All solvent volumes are marked on containers for visual inspection.

Figure D-4. Shipping transfer form.

DATA TRANSFER

The analytical group will be responsible for providing SYSTECH with an accounting of its analytical work suitable for incorporation into a final report on the results of the test program. Results of analytical work will be presented to SYSTECH in terms of concentrations of compounds found in the samples, including relevant information on quality control, spike recoveries, and limits of detection.

APPENDIX E

SAFETY PROGRAM

INTRODUCTION

Because of the significant health risks posed by exposure to TCDD and other trace organics, this safety program will be presented in two sections. The first section will describe general safety procedures and conditions required for a general field testing effort. The second section will describe additional procedures and conditions necessitated by the potential risk of toxic trace organics. This section has been developed from procedures presented in the Federal Register, Vol. 44, No. 233, Monday, December 3, 1979. It represents a minimum safety program and reflects SYSTECH's assessment of the current state of knowledge regarding the dangers inherent in contacting dangerous trace organics in a sampling effort.

GENERAL PROGRAM

The purpose of this plan is to ensure that adequate safety standards are established and adhered to during performance of the program.

Responsibility and Authority

The program manager will be responsible for program safety enforcement in cooperation with facility management. The program manager or his designee will ensure that:

A. Maximum safety features consistent with program requirements are incorporated into the test system.

B. Safety controls are maintained during test facility operations.

C. Facility safety equipment is operable and special equipment is available.

Potential Hazards

Hazardous Areas--

There are several areas at the test site that can be considered hazardous to test personnel and visitors. These potential hazards are as follows.

A. Gas Sampling Areas

The two potential hazards in the sampling area are:

- Handling hot probes
- Flue gases escaping as the result of loose fitting sampling probes

B. Hot Flue Gases

Any time sampling probes are accessed to the boiler or stack, extreme care must be exercised to prevent a back blast of the hot gases in the face of the operator.

General Safety Precautions--

All personnel involved in the test should wear safety glasses and hard hats when working in areas the program manager has determined to require their use. These should be supplied for all personnel working in these areas as well as for all visitors. Safety helmets and glasses must conform to Occupation Safety Health Administration (OSHA) and other applicable standards. Supervisors should wear white hard hats, workers green hard hats, and visitors red hard hats, to provide rapid personnel identification. Safety shoes and work clothes should be provided for those personnel identified by the program manager or his designee. While working with certain tests, chemical spills are possible. Should hazardous chemicals be spilled on a worker or a visitor, contaminated clothing should be removed promptly and laundered before reuse. Affected areas of the body should be washed thoroughly with soap and water. Eyes should be washed with water alone. A washroom for the personnel should be provided.

Handling of Ash--

During the handling of ash samples, it is possible that fugitive dust will be generated. Because of the potentially dangerous nature of the material being handled, precautions should be taken by the personnel working with these materials to protect themselves from exposure. OSHA approved dust masks should be provided to those personnel working with this material. If the program manager believes that the fugitive dust loading is excessively high, testing should be conducted to quantify the hazards and additional corrective measures instituted to protect the health of project personnel.

Sample Acquisition--

During the emissions testing, personnel may be required to perform tests from scaffolding. The program manager or his designee should be responsible for inspecting the test setup to ensure the adequacy of the scaffolding and related hardware before the testing begins. Inspection should include adequacy of railings and access ways. All personnel working in an exposed area must wear safety harnesses. All test sites should be designed to include inclement weather protection. In the event of extreme weather conditions, e.g., severe thunderstorms or high winds, testing should be postponed.

Safety Equipment At Test Sites

A. Fire extinguisher.

B. Telephone numbers of emergency agencies (to be posted near the telephone and inside hard hats).

C. Hard hats, safety glasses, and shoes.

D. First aid kit.

Operations

Visitors--

All visitors must be escorted through the site at all times. Good safety practice and the nature of the location requires that there be no exceptions to this rule.

Emergency Shutdown--

The test coordinator will be responsible for all testing performed on the site. Emergency shutdown of the testing should be at the discretion of the program manager and/or the personnel in charge of the boiler test facility.

TRACE ORGANIC PROGRAM

Several additional safety procedures and conditions will be followed to minimize the exposure of personnel to toxic trace organic compounds. Sampling personnel will wear gloves and safety glasses at all times when handling samples. Hands and arms will be thoroughly washed after sampling and before and after eating. When inhalation of dusts is a potentiality, OSHA approved dust masks will be worn by all personnel involved.

Personnel involved in the sample recovery and cleanup phases of the stack sampling program will exercise proper laboratory procedures at all times. Disposable gloves will be worn by personnel involved in these activities. No smoking or eating will be permitted in the laboratory trailer.

Every attempt will be made to carefully confine all potentially dangerous materials during these activities. This will be accomplished by working in designated cleanup areas, discarding all solvents in appropriate carboys, and thoroughly cleaning the work areas before and after activities.

For further information on specific safety precautions required in handling TCDD, the reader is referred to information presented in the Federal Register, Vol. 44, No. 233, Monday, December 3, 1979. This material will serve as a general guide for safety considerations involved in sampling and analysis for TCDD. Specific safety precautions implemented by analysts in their work will be under their responsibility.

APPENDIX F

PROCEDURES MANUAL FOR MODIFIED METHOD 5

INTRODUCTION

Because of the complexity of operating the MM5 train and recovering a sample from it, a detailed procedures manual has been developed to facilitate field use of this train. This manual includes sections describing pretest preparations, recovery procedures, sample handling and storage, and laboratory facilities.

PRETEST PREPARATIONS

The preparation of glassware, filters, and aluminum foil is completed prior to departure for the test site. The procedures for the various preparations are as follows.

Glassware Preparation

Each piece of glassware which is in contact with the sample is cleaned according to the following procedure.

1. Wipe off all excess vacuum grease.
2. Wash with soap and water.
3. Completely submerse in chromic acid for a minimum of 6 hours. This allows two batches to be cycled during a normal 8-hr work day.
4. Thoroughly rinse with tap water.
5. Rinse with distilled water.
6. Rinse with solvent.
7. Seal exposed ends with clean (solvent scrubbed) aluminum foil.

This procedure is performed prior to each new test program or when changing to a new test condition.

Aluminum Foil Preparation

Aluminum foil is used to cap openings of the glassware after cleaning and during several stages of the recovery process. Because the foil is used to prevent entry of potential contaminants, it must be solvent washed.

1. One side of the foil is wiped with a Kimwipe and solvent. It has been found that a large Kimwipe, folded and held with the sponge clamps, provides adequate scrubbing action. As the Kimwipe gets dirty, it can be refolded or replaced. The sponge clamps eliminate contamination from solvent contact with the person's hands.

2. After scrubbing, the foil is held with the clamps or forceps and rinsed with solvent.

3. The foil is then folded, cleaned sides together, and stored in either a clean sample jar or wrapped in a large piece of clean foil.

Various sized pieces of foil are required throughout the recovery procedure. Cutting several pieces into approximate 2- to 3-in. squares prior to use may be helpful in respect to recovery time. Large pieces of clean foil are required to protect each clean filter.

Filter Preparation

Prior to use, all Modified Method 5 particulate filters are solvent rinsed by the following procedures.

1. Set up a vacuum filtration system using a 1-ℓ flask and a 10-in. funnel. The filter frit and gasket are set in the funnel. This serves as a support for the filters.

2. Up to 25 filters are cleaned at one time using 1 liter of solvent. The top and bottom 3 filters are discarded.

3. As soon as all the solvent has passed through, the vacuum is shut off. This reduces the amount of air drawn through the filters and the risk of potential contamination.

4. Each cleaned filter is then sealed in a clean piece of aluminum foil.

Glass Wool Preparation

Glass wool is used to plug the resin chamber section of the sorbent trap. As it is in direct contact with the sample, the glass wool must be thoroughly cleaned.

1. Depending on the number of test runs, cut a sufficient quantity of glass wool and place in a cleaned sample jar. A 500-cc jar is usually sufficient.

2. Extract the glass wool three times with 300 to 400 cc of $CH_2OH:CH_2Cl_2$ (1:1). (The volume of solvent should be adjusted accordingly with the quantity of glass wool.)

3. The glass wool may then be stored in the sample jar until needed.

Assembly/Leak Check

The general configuration of the Modified Method 5 train is essentially the same as the Standard Method 5 train. The variations in assembly are as follows.

1. Vacuum grease may not be used on any surface which has sample contact. This includes the surfaces between the probe nozzle and the outlet of the No. 3 impinger. Two methods for obtaining leak tight seals have been tried to date. Teflon sleeves (Ace Glass No. 7556-06) were used initially. Although they are designed for applications where a lubricant cannot be used, the added thickness (0.38 mm) around the joint makes a leak tight seal very difficult to obtain. The added thickness also increases the liklihood of breakage at the ground glass joints.

   Wide Teflon tape stretched over the spherical member of the joint is the current method of choice. This method results in a thin, smooth Teflon layer which seals quite well. A hole is cut in the center of the stretched Teflon with a solvent rinsed razor blade.

2. The sorbent trap is situated between the filter assembly outlet and the first impinger. Structural supports have been constructed to hold the sorbent trap in a vertical position on the back side of the oven section of the sample box. It is positioned condensor section down, resin chamber up. Teflon tubing with appropriate hose adaptors is used to make the connection from the filter outlet to the condensor inlet and from the resin chamber outlet to the Impinger No. 1 inlet.

3. The arrangement of the impingers and their respective solutions are as follows:

No. 1 - Greensburg-Smith	100 mℓ HPLC H_2O
No. 2 - Modified Greensburg-Smith	empty
No. 3 - Modified Greensburg-Smith	empty
No. 4 - Modified Greensburg-Smith	Silica gel - full capacity

4. The particulate filter is not preweighed.

RECOVERY OF THE ORGANIC SAMPLE FROM MODIFIED METHOD 5 SAMPLE TRAIN

Philosophy of Sample Recovery

Recovery of the Modified Method 5 sample should be accomplished with minimal exposure of sample and sample contact surfaces to potential contaminants. Contamination may result from excessive exposure to the laboratory atmosphere, improper handling, or the use of improperly cleaned equipment. The primary methods of reducing potential contamination are:

1. Disassembling one train component at a time.

2. Immediately capping the exposed sample contact areas with solvent rinsed aluminum foil.

3. Wearing two pairs of gloves (nylon over cotton) while recovering the sample.

4. Solvent rinsing all tools (tweezers, spatulas, scissors, etc.) immediately prior to each use.

For the purpose of this test, it is felt that the recovery of an uncontaminated sample is more important than the complete recovery of all material trapped by the train. For example, if silica gel is found in the No. 3 impinger, it is better to eliminate recovery of the No. 3 impinger than to contaminate the impinger sample with silica gel. A notation in the log book would then be made explaining the circumstances requiring this procedure change. This philosophy is what separates the recovery procedure from cleaning. Recovery includes reclaiming only that part of the sample which will wash out through repeated solvent rinses. For example, the Standard Method 5 procedure for recovering the sample from the probe requires that the probe be washed and brushed. Recovery of the sample from the MM5 probe requires only a solvent rinse. After the solvent rinse is completed and the sample properly stored, the probe may then be "cleaned" by brushing.

For notation of various operating and recovery conditions, a log book is maintained. Daily entries are made by the stack and recovery teams. Figure F-1 is a summary sheet of data pertinent to normal MM5 sampling and recovery work. Besides that information, the log book is used to note any unusual circumstances which may occur during operation or sample recovery.

Sample Recovery Procedures

A schematic of the recovery procedures is indicated in Figure F-2.

Particulate sample (3-P) includes rinses from:

- probe nozzle
- probe
- control device bypass
- upper half of filter housing
- particulate filter

Date:

Location:

Fuel type:

Combustion resin system _____ or MM5 _____

Sample volume:

Leak check:

Laboratory	Field
Rate: _____ CFM	Rate: _____ CFM
Initial meter reading: _____ CF	Initial meter reading: _____ CF
Final meter reading: _____ CF	Final meter reading: _____ CF

Solvent used in recovery of MM5

3 - I - A	_____
3 - XR - A	_____
3 - P - A	_____
Subtotal	_____
3 - I - B	_____
3 - XR - B	_____
3 - P - B	_____
Subtotal	_____
TOTAL	_____

Combustion resin system

4 - I	_____
4 - XR	_____
TOTAL	_____

Figure F-1. Organic stack sampling: daily summary.

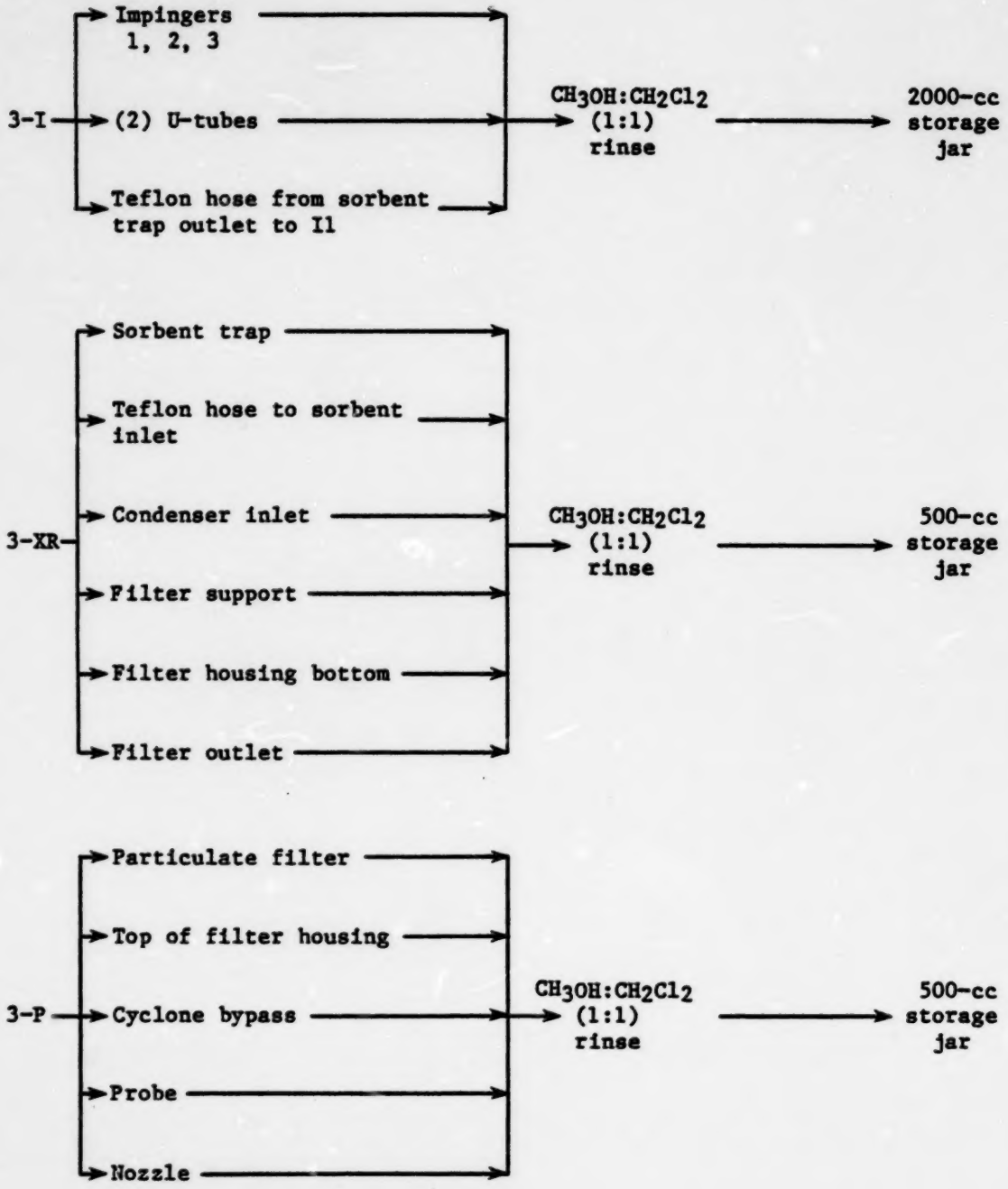


Figure F-2. Modified Method 5 sample recovery.

Procedure--

Weigh in the solvent wash bottle. Remove the probe nozzle from the probe and cap the exposed end of the probe with clean aluminum foil.

Nozzle--

Rinse the interior surfaces of the nozzle with solvent, being careful not to rinse over the exterior surfaces. It is suggested that solvent be introduced through both ends of the nozzle to ensure adequate rinsing of all interior surfaces. Recap the ends of the nozzle with clean aluminum foil.

Probe (Requires Two People)--

Hold the outlet end of the probe over the sample recovery funnel and elevate the nozzle end slightly. Introduce a stream of solvent into the nozzle end while rotating the probe slowly. Continue to rotate through three to four rotations while rinsing with approximately 100 to 200 cc of solvent. (Note: The probe interior is NOT brushed as in the Standard Method 5 procedure. Recap ends with clean aluminum foil.)

Control Device Bypass--

Remove control device bypass and cap upper half of filter housing with clean aluminum foil. Introduce approximately 10 to 20 cc of solvent into the control device bypass and rotate and agitate to contact all interior surfaces. Repeat this procedure three times.

Filter and Upper Half of Housing (Requires Two People)--

Disconnect and disassemble the filter housing and (with cleaned tweezers and spatula) carefully fold the particulate filter inward until it will fit into the sample bottle easily. Set aside the lower half of the filter housing and the frit in the clean area. Rinse the interior of the upper half of the filter housing by directing the solvent stream near the edge of the bell and rinsing down and out the neck. Care should be taken not to get too near the lip and contaminate the sample by washing down the exterior of the bell. Rinse around the bell three times. Set aside in clean area on clean aluminum foil.

Rinse down the sample recovery funnel and cap the sample bottle.

Reweigh the solvent wash bottle.

The resin sample (3-XR) bottle contains rinses from:

- filter frit
- lower half of filter housing
- U-connector
- modified impinger inlet connector
- Teflon connecting tube
- resin trap/condensor

Frit--

Pick up the frit with cleaned tweezers and carefully remove the Teflon tape from around edges. Discard the tape and rinse the frit into a sample

recovery funnel. Rinse with approximately 50 cc of solvent and set the frit aside in clean area on clean aluminum foil.

Lower Half Filter Housing--

Rinse in same manner as upper half and set aside in clean area on clean aluminum foil.

U-tube Connector--

Disconnect and rinse by partially filling with solvent (10 to 20 cc), rotating and agitating to ensure solvent contact on all interior surfaces. Repeat three times.

Oven Outlet Connector--

Rinse the interior surfaces of the connector with solvent. To ensure complete rinsing, it will be necessary to introduce the solvent from both ends of the piece. Use approximately 50 cc of solvent.

Teflon Connectors--

Disconnect and rinse the connectors three times with approximately 10 to 20 cc of solvent, using a rocking motion to ensure contact with all inner surfaces.

Resin Trap/Condensor--

With solvent rinsed tweezers, remove the glass wool plug from the end of the resin chamber and place it directly into the sample container, being careful not to lose any of the resin. Invert the resin trap over the sample recovery funnel and rinse through the condensor, the frit, and out the resin chamber into the sample container. The condensor section of the trap should be filled with solvent with a vigorous spraying action and then allowed to drain through the frit and resin chamber approximately four to five times. Use 200 to 300 cc of solvent.

Set the condensor aside in the clean area and allow to dry.

Rinse down funnel and close sample bottle.

Reweigh solvent squirt bottle.

Impingers and Connectors--

Impinger sample bottle (3-I-1,2,3,) contains rinses and condensate from:

- resin trap outlet connector
- impinger No. 1
- U-tube connector
- impinger No. 2
- U-tube connector
- impinger No. 3

As U-tubes are disconnected, they can be taken directly to sample recovery hood and rinsed three times with approximately 5 to 10 cc of the solvent mixture. Disconnected impingers are immediately capped off with clean

aluminum foil, weighed to determine weight gain, and placed in the sample recovery hood.

Without disconnecting the impinger stem from the bottom, pour out the impinger contents through the side arm into the sample bottle. Rinse three times with 20- to 30-cc portions of solvent by squirting the solvent down the center tube into the impinger. Agitate the solvent so that it splashes over the outer surface of the inner tube and completely rinses over the inner surfaces of the impinger bottom. Pour the solvent rinses out through the side arm into the sample bottle. The impingers can now be recapped until train is reassembled for the next run.

Rinse down the funnel with solvent into the sample bottle. Weigh the squirt bottle.

SAMPLE HANDLING

As charted in Figure F-2, samples are stored in either 500- or 2000-cc storage jars. Each jar is labeled with the appropriate sample code, site location, date, recovery time, and initials of recovery team members.* The volume level of the sample is then marked on the storage jar. To protect the samples from photochemical degradation, each sample jar is completely wrapped in aluminum foil. This foil does not have to be solvent cleaned. After wrapping, the storage jar is relabeled, as before.

LAB REQUIREMENTS

General physical requirements for the lab include:

- explosion proof hood - 4 to 6 ft wide
- laminar flow hood - hepa filtered air
- 6 to 12 ft of bench top work area

Ideally, the lab should be a positive pressure clean room environment, free from any sources of volatile or particulate organics. All sample recovery work is done under the hood. The work area of the hood should be cleaned and covered with clean room sheeting. The workbench surface is also wiped down with solvent and covered with clean room sheeting. Various types of support equipment are used to aid in sample recovery. These include:

- Stainless steel tray to serve as a solvent catch basin when rinsing items not included in the sample recovery scheme.

- A ring stand and a large ring to support the funnel over the sample jar.

---

* Each leg of the Modified Method 5 is identified by either an A or B at the end of the label information. Sample blanks are identified on the sample log only by the word BLANK following the label sequence.

- Two Teflon wash bottles--one which contains a known amount of solvent and is used exclusively for sample recovery, and another one used for various solvent rinses outside the sample recovery scheme.

- Clean foil to rest glassware on during recovery procedure.

- Tweezers, spatula, sponge clamp, etc.

APPENDIX G

DATA SHEETS

Analyst _____

SOLID WASTE FEED RATE DATA

Weight of load cell	Time

DAILY RESIDUE WEIGHT DATA

Date _____ Location _____ Analyst _____

Date	Time	Container tare weight (lb)	Gross weight (lb)	Net weight wet (lb)

Daily total wet residue generated _____ lb

Ash container to be removed twice per day at same times each day.

CONTROL DEVICE ASH DATA CALCULATION REPORT

Date _____ Location _____

Fly ash gross weight	_____	lb
Ash container tare weight	_____	lb
Net fly ash weight	_____	lb
Average combustible content	_____	percent
Heating value	_____	Btu/lb

PRIMARY FUELS REPORT

Date _____ Location _____ Tank _____

Usage (gallons)

Monday	Tuesday	Wednesday	Thursday	Friday	Total

Fuel type _____

Higher heating value _____ (Btu/lb)

Lower heating value _____ (Btu/lb)

Density _____ (lb/gal)

Moisture _____ (percent)

Ultimate analysis

(percent wt)

Carbon _____

Hydrogen _____

Oxygen _____

Nitrogen _____

Chlorine _____

Sulfur _____

Inerts _____

AUXILIARY FUELS USAGE REPORT

Date _____ Location _____

Fuel type _____

Usage (gallons)

Monday	Tuesday	Wednesday	Thursday	Friday	Total

Higher heating value _____ (Btu/lb)

Lower heating value _____ (Btu/lb)

Density _____ (lb/ft^3)

LP gas Type: Propane _____
Butane _____
Hexane _____

Weekly usage _____ (SCF)

Weekly usage _____ (lb)

Higher heating value _____ (Btu/lb)

Lower heating value _____ (Btu/lb)

Density _____ (lb/SCF)

Weekly heat input _____ (Btu)

CONTROL DEVICE ASH SAMPLES

Location _____

Date _____

Analyst _____

TRACE ORGANIC SAMPLE DATA SHEET

Sample type	Sample ID no.	Time _____ Gross	Tare	Net	Sample ID no.	Time _____ Gross	Tare	Net	Sample ID no.	Time _____ Gross	Tare	Net

COMPOSITING SCHEME

Sample ID no.	Sample time	Weight sample composited	Composite ID number	Composite weight
		gross tare net		gross tare net
		gross tare net		
		gross tare net		

BOTTOM ASH SAMPLES

Location _____

Date _____

Analyst _____

TRACE ORGANIC SAMPLE DATA SHEET

Sample type	Sample ID no.	Time _____ Gross	Tare	Net	Sample ID no.	Time _____ Gross	Tare	Net	Sample ID no.	Time _____ Gross	Tare	Net

COMPOSITING SCHEME

Sample ID no.	Sample time	Weight sample composited	Composite ID number	Composite weight
		gross tare net		gross tare net
		gross tare net		
		gross tare net		

PRIMARY FUELS SAMPLES

Location _____

Date _____

Analyst _____

TRACE ORGANIC SAMPLE DATA SHEET

Sample type	Sample ID no.	Time _____ Gross	Tare	Net	Sample ID no.	Time _____ Gross	Tare	Net	Sample ID no.	Time _____ Gross	Tare	Net

COMPOSITING SCHEME

Sample ID no.	Sample time	Weight sample composited	Composite ID number	Composite weight
		gross tare net		gross tare net
		gross tare net		
		gross tare net		

AUXILIARY FUELS SAMPLES

Location _____

Date _____

Analyst _____

TRACE ORGANIC SAMPLE DATA SHEET

Sample type	Sample ID no.	Time _____ Gross	Tare	Net	Sample ID no.	Time _____ Gross	Tare	Net	Sample ID no.	Time _____ Gross	Tare	Net

COMPOSITING SCHEME

Sample ID no.	Sample time	Weight sample composited	Composite ID number	Composite weight
		gross tare net		gross tare net
		gross tare net		
		gross tare net		

EP TOXICITY RESULT

Ash Leachate

Contaminant	Bottom ash mg/ℓ	Fly ash mg/ℓ
Arsenic		
Barium		
Cadmium		
Chromium		
Lead		
Mercury		
Selenium		
Silver		
Endrin		
Lindane		
Methoxychlor		
Toxaphene		
2,4-D		
2,4,5-TP		

Plant Location _____

Date of Sampling _____

Time of Sampling _____

HYDROCARBON SPECIES

1. Column flow rate (mℓ/min) _____ 2. Recorder speed _____

3. Full scale (mV) _____ 4. Column pressure (psi) _____

5. Electrometer set (A/mV) _____ 6. Calibration date _____

7. Sample size _____

8. Oven conditions _____

9. Attenuation _____ 10. Range _____

11. Observations _____ _____

12. Type of sampling container _____

13. Are sample responses bracketed with standards? _____

14. Analyst responsible _____ Date analyzed _____ Time _____

15. Reviewed by _____ Date _____

Sample/ Standard	Sample Component Gas	Uncorrected sum of peak areas	Blank value	Retention time	Corrected sum of peak areas	Concentration percent	Sensitivity	High/low calibration standards	Concentration ppm

MODIFIED METHOD 5 ANALYTICAL DATA

Plant _____ Sample No. _____
Sampling location _____ Run No. _____
Recovered by _____ Recovery date _____ Run date _____
Comments _____
Analyst responsible _____
Calculations and report reviewed by _____ Report date _____

FILTERS USED

No. _____

_____

_____

_____

_____

IMPINGER VOLUMES

	Initial	Final	
First	_____ ml	_____ ml	
Second	_____ ml	_____ ml	
Third	_____ ml	_____ ml	
Totals	_____ ml	_____ ml	Gain _____ ml

SILICA GEL WEIGHTS

Initial	Final	
_____ g	_____ g	
_____ g	_____ g	
_____ g	_____ g	
Totals _____ g	_____ g	Gain _____ ml

CONDENSATE

Total volume collected _____ ml _____ ml

Initial resin weight _____

Total gain _____ ml

METHOD 5 Test No. _____ Time _____ to _____ PROJECT _____
Analyst _____ DATE _____
Checked by _____

PARTICULATE EMISSION CALCULATIONS

1. PARTICULATE COLLECTED

$$M_n = \left[\left\{\begin{matrix}\text{Total}\\ \text{weight}\\ (g)\end{matrix}\right\} - \left\{\begin{matrix}\text{Tare}\\ \text{weight}\\ (g)\end{matrix}\right\}\right] 1000 = [(\quad) - (\quad)]\ 1000 = _____ \text{ mg}$$

Where: M_n = total particulate collected

2. SAMPLED DRY GAS VOLUME AT STANDARD CONDITIONS $V_{m_{STD}}$

$$V_{m_{STD}} = 17.64 \left\{\frac{V_m}{T_m °R}\right\} \left\{P_b + \frac{\Delta H}{13.6}\right\} (Y)$$

$$V_{m_{STD}} = 17.64 \left[\frac{(\quad)}{(\quad)}\right] \left[(\quad) + \frac{(\quad)}{13.6}\right] (\quad) = _____ \text{ SCF}$$

Where: $V_{m_{STD}}$ = Sampled dry gas volume at Standard Conditions, SCF

V_m = Sampled dry gas volume at meter conditions, CF

T_m = Average gas meter temperature, °R

P_b = Barometric pressure, in. Hg

Y = Dry gas meter correction factor

3. SAMPLED WATER VAPOR VOLUME AT STANDARD CONDITIONS

($V_{w_{STD}}$ = SCF at 68°F and 29.92 in. Hg)

$$V_{w_{STD}} = \left\{0.0474 \frac{ft^3}{m\ell}\right\} V_{lc} = 0.0474 \times (\quad) = _____ \text{ SCF}$$

Where: V_{lc} = Volume of liquid collected in impingers and silica gel.

4. TOTAL SAMPLED VOLUME AT STANDARD CONDITIONS

($V_{t_{STD}}$ = SCF at 68°F and 29.92 in. Hg)

$V_{t_{STD}} = V_{m_{STD}} + V_{w_{STD}} = (\quad) + (\quad) =$ _____ SCF

PERCENT H_2O IN SAMPLED GAS AT STANDARD CONDITIONS

$$\text{Percent } H_2O = \frac{V_{w_{STD}}}{V_{t_{STD}}} \times 100 = \frac{(\quad)}{(\quad)} \times 100 = _____ \text{ percent}$$

Where: $V_{m_{STD}}$ = Volume of dry gas sampled at Standard Conditions.

$V_{w_{STD}}$ = Water vapor volume sampled at Standard Conditions.

V_t = Total sampled volume (dry and wet) at Standard Conditions

GAS FLOW CALCULATIONS

5. STACK AREA (A = ft^2; L, W, and d in inches)

A (circ.) = $5.454 \times 10^{-3} (d)^2 =$

$5.454 \times 10^{-3} (\quad)^2 =$ _____ ft^2

A (rect.) = (L × W) $6.944 \times 10^{-3} =$

$(\quad) \times (\quad) \; 6.944 \times 10^{-3} =$ _____ ft^2

Where: A = Cross sectional area of duct, ft^2

L = Length of rectangular duct, inches

W = Width of rectangular duct, inches

d = Diameter of circular duct, inches

6. MOLECULAR WEIGHT OF STACK GAS

$M_d = 0.440\ (\%\ CO_2) + 0.320\ (\%\ O_2) + 0.280\ (\%\ CO + \%\ N_2)$

$M_d = 0.440\ (\quad) + 0.320\ (\quad) + 0.280\ (\ +\ ) =$ _____ lb/lb mole

$$M_s = M_d \left\{1 - \frac{\%\ H_2O}{100}\right\} + 18 \left\{\frac{\%\ H_2O}{100}\right\}$$

$M_s = M_d\ (1 -\ \ ) + 18\ (\quad) =$ _____ lb/lb mole

Where: M_d = Dry molecular weight of stack gas

M_s = Wet molecular weight of stack gas

7. AVERAGE STACK VELOCITY AT STACK CONDITIONS (V_s = FPM)

$$V_s = 85.49\ C_p \left\{\sqrt{\Delta P}\right\} \left\{\sqrt{\frac{T_s}{P_s\ M_s}}\right\} (60)$$

$V_s = 85.49\ (\quad) \{\sqrt{\quad}\}\{\sqrt{(\quad)(\quad)}\} = (60) =$ _____ FPM

Where: C_p = Pitot tube coefficient

ΔP = Velocity pressure in stack, inches H_2O

T_s = Temperature of stack gas, °R

P_s = Pressure in stack

M_s = Molecular weight of stack gas, wet basis

8. GAS GLOW RATE AT STACK TEMPERATURE (Q = CFM)

$Q = V_s$ average × A at T_s average

$Q = (\quad) \times (\quad) =$ _____ CFM at _____ °F

Where: V_s = Average stack gas velocity, ft/sec

A = Area of duct, ft^2

9. GAS FLOW RATE AT STANDARD CONDITIONS (Q_{STD} = SCFM)
(70°F, 29.92 in. Hg)

$$Q_{STD} = 17.714 \times Q \times \frac{P_b}{T_s °R}$$

$$= 17.714 \times (\quad) \times \frac{(\quad)}{(\quad)} = _____ \text{ SCFM}$$

Where: Q = Gas flow rate at stack temperature

P_b = Barometric pressure, inches Hg

T_s = Temperature of stack, °R

10. DRY GAS FLOW RATE AT STANDARD CONDITIONS (Q_{DSTD} = Dry SCFM)

$$Q_{D_{STD}} = \left\{1 - \frac{\text{Percent } H_2O}{100}\right\} Q_{STD}$$

$$Q_{D_{STD}} = (1 - \quad)(\quad) = _____ \text{ DSCFM}$$

Where: Q_{STD} = Gas flow rate at Standard Conditions

11. PARTICULATE CONCENTRATION - DRY BASIS C's

C_s (gr) = gr/SCF, dry basis

C_s (lb) = lb/SCF, dry basis

$$C_s \text{ (gr)} = 0.0154 \left\{\frac{M_n}{V_{m_{STD}}}\right\} = 0.0154 \left[\frac{(\quad)}{(\quad)}\right] = _____ \text{ gr/SCF}$$

$$C_s \text{ (lb)} = 1.428 \times 10^{-4} \times C_s \text{ (gr)} = 1.428 \times 10^{-4} (\quad)$$

$$= _____ \text{ lb/SCF}$$

Where: M_n = Total particulate matter collected

$V_{m_{STD}}$ = Sampled dry gas volume at Standard Conditions

12. PARTICULATE EMISSION RATE (lb/hr)

$E_p = 60 \times C_s\ (lb) \times Q_{D_{STD}} = 60\ (\quad)\ (\quad) = _____$ lb/hr

Where: C's = Particulate concentration, lb/SCF dry basis
$Q_{D_{STD}}$ = Dry gas flow rate at Standard Conditions

13. BTU INPUT (10^6 BTU/HR)

$$\text{Btu input} = \frac{(\text{Fuel usage, units/hr})\ (\text{Heat value, Btu/unit})}{10^6}$$

$$\text{Btu input} = \frac{(\quad)\ (\quad)}{10^6} = _____\ (10^6 \text{ Btu/hr})$$

14. EMISSION RATE IN TERMS OF BTU INPUT (E_{Btu} = lb/10^6 Btu)

$$E_{Btu} = \frac{E_p}{\text{Btu input}} = \frac{(\quad)}{(\quad)} = _____ \text{ lb/}10^6 \text{ Btu}$$

Where: E_p = Particulate emission rate, lb/hr

15. COMPUTATION OF ISOKINETIC VARIATION (I = percent)

$$I = \left[\frac{A\ V_{m_{STD}}}{\theta Q_{D_{STD}}\ A_n} \right] 100$$

$$= \left[\frac{(\quad)\ (\quad)}{(\quad)\ (\quad)\ (\quad)} \right] 100$$

$$= \left[\frac{(\quad)}{(\quad)} \right] 100$$

I = _____ percent

Where: A = Cross sectional area of duct, ft^2

$V_{M_{STD}}$ = Sampled dry gas volume at Standard Conditions

θ = Total time sampled, minutes

$Q_{D_{STD}}$ = Dry gas flow rate at Standard Conditions

A_n = Cross sectional area of nozzle, ft^2

DEFINITION OF TERMS

A = Cross sectional area of duct, ft^2

A_n = Sampling nozzle cross section area, ft^2

C_{Hn} = Concentration of n hydrocarbon in stack gas, lb/SCF

$C_s(gr)$ = Particulate concentration in stack gas, gr/SCF (sample concentration method)

$C_s(lb)$ = Particulate concentration in stack gas, lb/SCF (sample concentration method)

$C'_s(gr)$ = Particulate concentration in stack gas, gr/SCF (ratio of area method)

d - Diameter of circular duct, in.

E_{Btu} = Emissions rate in terms of Btu input, $lb/10^6$ Btu

E_{Hn} = Hydrocarbon emission rate for hydrocargon n, lb/hr

E_p = Particulate emission rate, lb/hr

ΔH = Average pressure differential across orifice in meter box, in. H_2O

I = Percent of Isokinetic sampling

K_1 = Velocity constant (includes S or standard pitot coefficient)

K_2 = Velocity constant

$K_n = K_1 + K_2$

L = Length of rectangular duct, in.

M_n = Total amount of particulate collected, mg

P_b = Barometric pressure, in. Hg

ΔP_n = Velocity pressure at point n, in. H_2O

Q = gas flow rate at stack temperature, CFM

Q_{std} = Gas flow rate at standard conditions (70°F, 29.92 in. Hg) SCFM

$Q_{D\ STD}$ = Dry gas flow rate at standard conditions (70°F, 29.92 in. Hg) DSCFM

$T_m°F$ = Average gas meter temperature, °R (460 + °F)

$T_m°R = T_m°F + 460$

T_s = Average stack temperature, °F

$T_s°F$ = Average stack temperature, °R (460 + $T_s°F$)

V_{lc} = Volume of liquid collected in impingers and silica gel, ml

V_m = Sampled dry gas volume at meter conditions, CF

$V_{m\ std}$ = Sampled dry gas volume at standard conditions, SCF

$V_{t\ std}$ = Total sampled volume (dry + wet) at standard conditions, SCF

$V_{w\ std}$ = Sampled water vapor volume at standard conditions, SCF

v_n = Velocity at stack condition, point n, FPM

$v_{n\ avg}$ = Average stack velocity at stack conditions, FPM

W = width of rectangular duct, in.

θ = total sampling time, minutes

C_{SO_2} = Sulfur dioxide concentration in stack gas, ppm by volume at standard conditions

E_{SO_2} = sulfur dioxide emission rate, lb/hr

C_{NO} = nitrogen dioxide concentration in stack gas, lb/SCF

E_{NO} = nitrogen dioxide emission rate, lb/hr

E_{NOB} = nitrogen dioxide emission rate, lb/10^6 Btu

M_x = mass of NO_x collected, as nitrogen dioxide, µg

V_f = volume of NO_x flask in ml of H_2O

V_{sc} = volume of NO_x sample collected, SCF

P_i = absolute pressure of NO_x flask initial, in. Hg

P_f = absolute pressure of NO_x flask final, in. Hg

T_i = temperature of NO_x flask initial, °R

T_f = temperature of NO_x flask final, °R

β = pitot correction factor

ε = temperature correction factor

σ = volumetric correction factor

PARTICULATE FIELD DATA

PLANT _____ AMBIENT TEMPERATURE _____ NOZZLE DIAMETER, in. _____ STACK NO. _____

DATE _____ BAROMETRIC PRESSURE _____ STACK DIAMETER, in. _____ RUN NO. _____

LOCATION _____ ASSUMED MOISTURE, % _____ METER $\Delta H@$ _____ FUEL _____

OPERATOR _____ PROBE LENGTH, in. _____ C FACTOR _____ BOILER SIZE _____

SAMPLING TIME/POINT _____ LEAK CHECK _____ PROCESS WEIGHT RATE _____

TIME	TRAVERSE POINT		VELOCITY HEAD Δ Ps	STATIC PRESSURE (IN. H_2O)	PUMP VACUUM IN. Hg GUAGE	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) IN., H_2O ACTUAL	DRY GAS SAMPLE VOL. (Vm) FT³	TEMPERATURES °F					
START /STOP	NO.	LOCATION IN.						STACK (T_s)	PROBE	OVEN	IMP OUT	IMP IN	METER OUT (Tm)

ORSAT MEASUREMENT

	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					
5					
6					

COMMENTS:

_____

_____

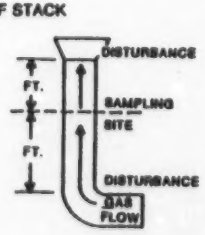
_____

_____

_____

_____ CROSS SECTION

SCHEMATIC OF STACK



PARTICULATE FIELD DATA

TIME	TRAVERSE POINT		VELOCITY HEAD ΔP_s	STATIC PRESSURE (IN. H_2O)	PUMP VACUUM	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (H) IN., H_2O, ACTUAL	DRY GAS SAMPLE VOL. (Vm) FT^3	TEMPERATURES °F					
START /STOP	NO.	LOCATION IN.						STACK (T_s)	PROBE	OVEN	IMP OUT	IMP IN	METER OUT (Tm)

PARTICULATE ANALYSIS

PLANT _____ DATE _____

BOILER _____ TIME _____

LOCATION _____ OPERATOR _____

FUEL _____

PARTICULATE COLLECTED (gm)			
CONTAINER NUMBER	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1. FILTER			
2. PROBE WASH			
3.			
TOTAL			m_n =

LIQUID COLLECTED (gm)			
WEIGHTS	INITIAL	FINAL	GAIN
IMPINGER NO. 1			
NO. 2			
NO. 3			
NO. 4			
SILICA GEL WT.			
TOTAL WEIGHT			V_w =

HOURLY PROCESS DATA

Date _____

Time								
Gas pressure boiler entrance								
Gas pressure leaving boiler								
Pres. exit dust collector								
Overfire air pressure								
Hearth air pressure								
Grate air pressure								
Charge counts								
ID fan current (amp)								
Steam integrator								
Load cell weight (lb)								
Primary temperature (°F)								
Secondary temperature (°F)								
Fuel oil 1 (gal)								
Waste oil 1 (gal)								
Fuel oil 2 (gal)								
Waste oil 2 (gal)								
Makeup water No. 1 (gal)								
Makeup water No. 2 (gal)								
Feed water (gal)								
Continuous blowdown (gal)								
Continuous blowdown (gal)								
Steam pressure (psig)								
Boiler water level								
Feed water temperature (°F)								
Makeup water temperature (°F)								
Blowdown temperature (°F)								
Ambient temperature (°F)								
Boiler outlet temperature (°F)								
Flue gas O_2 (percent)								
CO_2 (percent)								
CO (ppm)								

AVERAGE DAILY OPERATING CONDITIONS

Date _____ Location _____

	Mon	Tue	Wed	Thur	Fri	Average	Total
Temperatures (°F)							
Makeup water							
Feed water							
Blowdown							
Ambient							
Primary							
Secondary							
Boiler outlet							
Stack							
Steam							
Steam pressure (psig)							
Steam enthalpy (Btu/lb)							
Makeup water flow (lb)							
Steam integrator flow (lb)							
Continuous blowdown (lb)							
Intermittent blowdown (lb)							

INSTRUMENT CALIBRATION DATA

SYSTEMS TECHNOLOGY CORPORATION SYSTECH
245 N. Valley Rd. • Xenia, Ohio 45385 • 513/372-8077
A Systems Research Laboratories, Inc. Subsidiary

PROJECT: _____ DATE: _____

LOCATION: _____ OPERATOR: _____

	SO_x		NO_x		O_2		CO_2		CO		THC		COMMENTS
Chanel													
Std. Conc.													
Std. Span													
Date/Time	Zero	Span	Zero	Span	Zero	Span	Zero	Span	Zero	Span	Zero	Span	

PARTICULATE METALS, STACK OR CYCLONE

Element	Concentration in stack gas ($\mu g/m^3$)	Release rate (g/Mg of refuse)
Silicon		
Iron		
Aluminum		
Sodium		
Calcium		
Potassium		
Magnesium		
Lead		
Zinc		
Cadmium		
Beryllium		
Titanium		
Chromium		
Copper		
Nickel		
Manganese		
Lithium		
Antimony		
Boron		
Tin		
Vanadium		

EMISSIONS SUMMARY DATA SHEET

Location _____

General Date					
Barometric pressure (in. Hg)					
Gas Flow Data Stack area (ft^2)					
Average velocity at stack conditions (FPM)					
Flow rate at Stack Conditions (CFM)					
Stack temperature (°F)					
Flow rate at Standard Conditions (SCFM)					
Particulate Emission Data Total particulate collected (mg)					
Volume dry gas sampled at Std. Cond. (SCF)					
Total sampled volume at Std. Cond. (SCF)					
Particulate concentration (gr/SCF)					
Particulate emission rate (lb/hr)					
Particulate emission rate (lb/10^6 Btu)					
Percent isokinetic sample (percent)					
Gas Composition Data CO_2 (percent)					
O_2 (percent)					
CO (percent)					
 NO_x (ppm)					
SO_x (ppm)					
HC (ppm)					
Cl (ppm)					